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Northeast
National Petroleum Reserve-Alaska

DRAFT Supplemental
Integrated Activity Plan/Environmental Impact Statement

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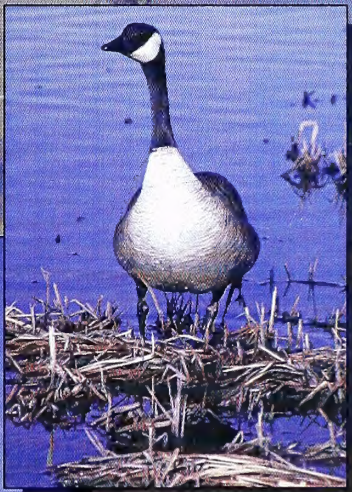

Alaska

In Cooperation with the
North Slope Borough

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To enhance the quality of life for all citizens through the balanced stewardship of America's public lands and resources.

Our Mission

To sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations.

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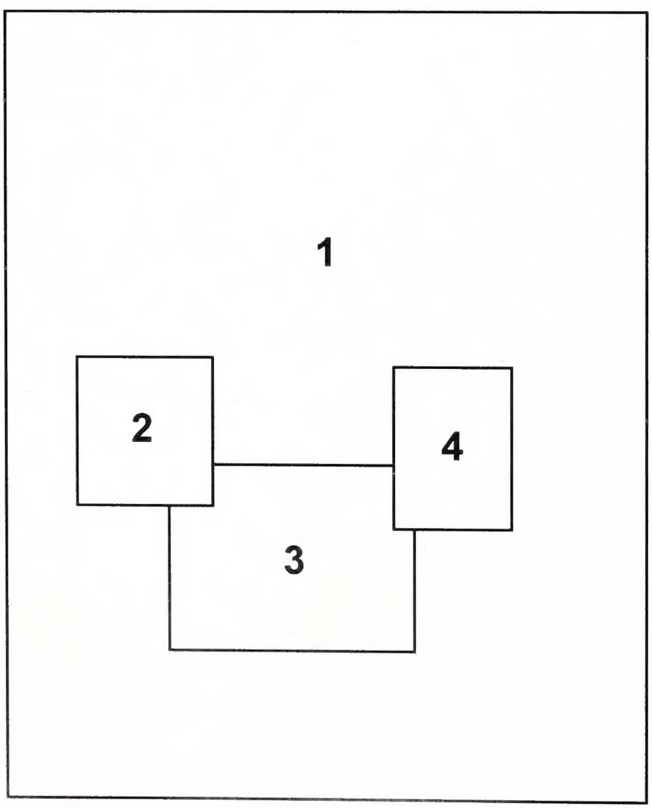

BLM Cover Photos:

1. Teshepuk Lake, Alaska. Photo by Richard Kemnitz.
2. Caribou, northern Alaska.
3. Drilling Rig at Hunter A well in the Northeast National Petroleum Revserve-Alaska.
   Photo by BLM Branch of Energy
4. Canadian Goose, northern Alaska.

Northeast National Petroleum Reserve–Alaska

Draft

Supplemental Integrated Activity Plan/ Environmental Impact Statement

VOLUME III:

Chapter 4 (sections 4.7-4.12), Chapter 5, Appendices, Bibliography, Glossary, List of Acronyms

Prepared by

U.S. Department of Interior
Bureau of Land Management
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In Cooperation with the North Slope Borough

August 2007

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Chapter IV: Environmental Consequences (sections 4.7 - 4.12)

4.7 CUMULATIVE EFFECTS

The National Environmental Policy Act and its implementing regulations require an assessment of the proposed action and other actions that have occurred in the past, are occurring in the present, or are likely to occur in the future, which together may have cumulative impacts that go beyond the impacts of the proposed action itself. As defined by 40 C.F.R. § 1508.7:

> "Cumulative impact" is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

The purpose of this cumulative effects analysis is to determine if the effects of the action proposed in this supplement, together with other past, present, and reasonably foreseeable future actions on the North Slope and eslewhere, have the potential to interact or accumulate over time and space, either through repetition or combined with other effects, and under what circumstances and to what degree they might accumulate.

Because many of the actions considered in this Supplemental IAP/EIS to be reasonably foreseeable contributors to the cumulative impacts are the same as those described in the Amended IAP/EIS, many of the types of cumulative impacts are the same as those described in that document. However, the analysis in this supplement has been substantially revised in response to the finding of the U.S. District Court for the District of Alaska that BLM failed to fully address the cumulative impact increased activity in the Northeast NPR-A planning area will have when combined with increased activity in the Northwest NPR-A planning area, and to update the cumulative oil and gas exploration and development scenarios to address the intervening increase in the price for oil. The changes to the cumulative impact analysis address the court's concern by focusing on the interrelationship of oil and gas leasing and development activities, and resulting cumulative impacts, between the Northeast and Northwest NPR-A. This discussion can be found in **section 4.7.3.3** and in the "Contribution of Supplement Alternatives to Cumulative Effects" sections of the subsections within **section 4.7.7**. The changes in the oil and gas scenarios (see **section 4.7.3** for scenarios associated with cumulative impacts), which have increased the expected amount of exploration and development activities, have resulted in increases in the amount, but not generally the type, of impacts. In addition, the cumulative impact analysis has been revised to take into consideration new contributors to cumulative impacts, most notably the Minerals Management Service's proposed Chukchi Sea oil and gas lease sale 193 and the State of Alaska's current initiative to have a gas pipeline built to deliver North Slope gas to market. The Supplemental IAP/EIS, however, deletes a road project that would have connected Nuiqsut and NPR-A to the existing road network east of the Colville River from the list of reasonably foreseeable actions because the State is no longer pursuing that project. In addition, the Supplemental IAP/EIS's cumulative impact analysis has incorporated relevant new studies, including some related to global climate change, and enhanced the discussion of potential public health impacts by adding a subsection specifically addressing those impacts.

4.7.1 Structure of the Cumulative Impacts Analysis

For this supplement, the analysis of cumulative impacts is a four-step process that follows guidance provided in Considering Cumulative Effects Under the National Environmental Policy Act (CEQ 1997) and Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope (NRC 2003):

1. Specify the class of actions whose affects are to be analyzed;
2. Designate the appropriate time and space domain in which the relevant actions occur;
3. Identify and characterize the set of receptors to be assessed; and
4. Determine the magnitude of effects on the receptors and whether those effects are accumulating.

4.7.1.1 Class of Actions Whose Affects are to be Analyzed

Both non-oil and gas activities and oil and gas activities, advances in technology, and climate change are considered in the analysis. The assumptions and scenarios used by the resource specialists in the analyses of the cumulative impacts include those identified for the planning area **in section 4.2, *Introduction and Basic Assumptions for the Environmental Consequences Assessment***.

Non-Oil and Gas Activities

Non-oil and gas activities include those activities that have occurred in the past, are presently occurring, or are likely to occur in the future. These include activities discussed in **section 4.2.1.1, *Activities Not Associated with Oil and Gas Exploration and Development***, that could occur within and outside of the Planning Area, and other North Slope activities, including resettlement and expansion of Native villages, and other residential, commercial, and industrial development on the North Slope, and military (DEW-Line) and other government sites.

Oil and Gas Activities

Oil and gas activities include those direct and indirect activities that have occurred in the past, are presently occurring, or are likely to occur in the future. These include the types of activities discussed in **section 4.2.1.2** that could occur within the planning area and on the North Slope. The activities likely to have the greatest effects vary by resource. For example, oil and gas activities considered in greatest detail in the cumulative impacts analysis for biological resources and subsistence users are:

- Exploration activities, including seismic activities, off-road travel, and exploration drilling
- Road construction (ice, peat, and gravel roads)
- Industrial activity (oil field development and production and related infrastructure)
- Oil spills
- Marine-related activities
- Site reclamation

In contrast, employment and income are important activities to consider when evaluating the economy. Activities analyzed for each resource are identified in **section 4.7.7**.

Advances in Technology

Over the past 2 decades, new technologies have been developed and applied to exploration, development, and production on the North Slope. Some technologies, such as the use of ice roads and ice pads for exploration wells, are unique to the Arctic and were largely developed in Alaska. Other advances, such as the use of coiled tubing, 3-D seismic-data acquisition, horizontal and multilateral drilling, measurement while drilling, low ground-pressure vehicles (Rolligons), and remote sensing were developed elsewhere. These technologies have been important in reducing cumulative effects to resources from oil and gas activities and are discussed in more detail in **section 4.7.4**.

Global Climate Change

This Supplemental IAP/EIS also considers the implications of global climate change in assessing cumulative effects. For example, the effects of past, current, and future activities on the North Slope could be much greater on the permafrost landscape than would be the case if the climate were more stable. While impacts of global climate change are likely to be most evident in the Arctic, the causes and impacts of global climate change are global in scope.

4.7.1.2 Appropriate Temporal and Spatial Domain

Temporal Domain

The analysis period covered by the cumulative effects analysis begins in approximately 1900, when first exploration on the North Slope began, and continues through about 2100. The ending date is based on the assumption that oil and gas fields will be discovered and developed in the planning area over approximately the next half century and that production and abandonment activities could last for approximately 50 more years.

Developments for which no solid proposal has been submitted or which seem unlikely to occur within the foreseeable future are considered speculative. Speculative developments are not considered reasonably foreseeable and are not analyzed as part of the cumulative impacts associated with this IAP/EIS.

Spatial Domain

For individual resources and uses, the area of which an effect could be felt could be the "footprint" of the proposed action, but for others the effect may extend well beyond that space. For example, noise effects to wildlife can extend miles beyond the footprint of the development. For purposes of this analysis and based on guidance from the National Research Council (NRC 2003), the spatial domain for past, present, and reasonably foreseeable activities is primarily the North Slope of Alaska and its adjacent marine waters. However, this supplement also considers cumulative effects to resources that could occur outside of Alaska and its adjacent marine waters, primarily to migratory birds and mammals.

4.7.1.3 Magnitude of Effects and Whether Those Effects are Accumulating

The potential extent of the total cumulative effects (e.g., number of animals and habitat affected, jobs and revenues created or lost), and how long the effects might last (e.g., population recovery time, duration of income flows) are estimated to determine the magnitude of effects that could accumulate for each resource. Where possible, the assessment of effects on a resource

is based on quantitative analysis (e.g., number of miles of gravel roads constructed; number of animals killed). However, many effects are difficult to quantify (e.g., animal behaviors; human perceptions) and a qualitative assessment of effects is made.

As suggested by the CEQ (1997) handbook, Considering Cumulative Effects Under the National Environmental Policy Act, this Supplemental IAP/EIS considers the following basic types of cumulative effects that might occur:

- "Additive" (loss of sensitive resources from more than one incident),
- "Countervailing" (negative effects are compensated for by beneficial effects), and
- "Synergistic" (total effect is greater than the sum of the effects taken independently).

Additive effects on specific resources often are difficult to detect and do not necessarily add up in the strict sense of one plus one equals two. It is much more likely that an additive effect would be greater than one but less than two. A synergistic effect, in theory, is a total effect that is greater than the sum of the additive effects on a resource. To arrive at a synergistic effect in this example (continuing with the numeric analogy), the total cumulative effect would need to end up greater than two. In the highly variable Arctic environment, where natural variations in population levels can exceed the impacts of human activity, such an effect would need to be much greater than the hypothetical two to be either measurable or noteworthy.

In the analyses that follows, effects should be considered to be additive in nature, unless otherwise noted. While synergistic impacts have been demonstrated in the laboratory (for certain types of chemical reactions, for example), there is almost no evidence of such impacts occurring when dealing with biological resources in the Arctic environment. Where synergistic impacts are not specifically accounted for in the analysis section, it is because there are neither studies nor information supporting the identification of such impacts. Resource analysts have striven to keep the cumulative analysis useful, manageable, and concentrated on meaningful potential effects. The cumulative analysis considers in greatest detail activities that are more certain to happen and that are geographically in or near the planning area.

4.7.2 Activities Not Associated with Oil and Gas Exploration and Development Considered in the Cumulative Effects Analysis

This Supplemental IAP/EIS analyzes cumulative impacts associated with past, present, and reasonably foreseeable non-oil and gas and oil and gas activities. Non-oil and gas actions include continued human activities such as sport and subsistence hunting and fishing, commercial fishing, tourism, and recreational activities. Such actions that would occur within the planning area are discussed in **section 4.2.1.1**. Other non-oil and gas activities that could occur on the North Slope include growth and development associated with villages and military sites on the North Slope. The history of non-oil and gas development is discussed in **section 4.7.2.1** below, and the effects from past, present, and reasonably foreseeable non-oil and gas development are discussed in **section 4.7.7**. (Note: The Amended IAP/EIS also considered state-sponsored development of roads from the Dalton Highway, which were under consideration during the early stages of developing the Amended IAP/EIS. The Supplement does not include analysis of impacts from such roads, however, because no permit applications have been filed and the road plans have become inactive. As such, we consider any such road development as speculative).

4.7.2.1 North Slope Development

There are presently seven North Slope villages being considered for this analysis: Point Lay, Wainwright, Atqasuk, Barrow, Nuiqsut, Anaktuvuk Pass, and Kaktovik. While a number of these locations were occupied at various times throughout the human history on the North Slope, much of the occupation prior to 1900 consisted of seasonal dwellings. These villages have been established or reestablished since 1900, and the establishment and subsequent growth represent cumulative impact to the North Slope environment. Villages consist of dwellings and other buildings, sewage and water systems, gravel roads, gravel airstrips/airports, and other structures. Their establishment, current area, and population growth are described below (Table 4.7-A and Table 4.7-B). (Most information in this section is available on the Alaska Department of Commerce, Community, and Economic Development's Community Database Online website at http://www.commerce.state.ak.us/dca/commdb/CF_BLOCK.htm and from the website of the North Slope Borough at http://www.north-slope.org/. Both websites were accessed on January 18, 2007).

The village of Point Lay has not been incorporated under State law as a municipality, but has been incorporated as a Native Village under the Indian Reorganization Act by the Bureau of Indian Affairs. Since the early 1970s, the village's population has grown from less than a few dozen residents to 260, of which approximately 86% were Iñupiat Eskimos. The village has gravel roads and an airstrip, cultural center, school, health clinic, police and fire stations, and local store. The NSB provides public electricity. The borough has recently provided a water and sewer project to the village. Transportation to the village is provided by scheduled airline and charter service at the local airport.

Wainwright was established in 1904 when an Alaska Native Service built a school there. The community was incorporated as a second-class city in 1962. Wainwright has been one of the larger villages in the borough, having 353 residents in 1973 and 556 thirty years latter. The village has gravel roads and an airstrip, cultural center, school, health clinic, police and fire stations, and local store. The NSB provides all utilities. Transportation to the village is provided by scheduled airline and charter service at the local airport.

The village of Atqasuk is at a site that has historically been the location of dwellings. Coal was mined in the community, then known as Meade River, in World War II and freighted to Barrow. The population dwindled in the 1960s but the village was re-established in the 1970s under the name Atqasuk, and incorporated as a second class city in 1982. Atqasuk has had a fairly consistent population since the late 1980s and in 2003 counted 250 residents, 91% of whom were Iñupiat Eskimos. The village has a public electricity system, a school, police and fire stations, airstrip, health clinic, and local store. About 85% of households have water piped to their house. Transportation to the village is provided by scheduled airline and charter service at the local airport.

Nuiqsut was established in 1974 when 27 families moved to the present location. The new residents lived in a tent city for 18 months before permanent housing could be built. The village was incorporated as a second-class city in 1975. In 2003, there were 416 residents in the village; about 92% were Iñupiat. The village has a school, health clinic, store, police and fire station, and public transportation system. All but one of the Nuiqsut households had running water in 2003. The village has a public utility (electricity) system and in late 2006 began receiving gas from the nearby Alpine oil field. Transportation to the village is provided by scheduled airline and charter service at the local airport.

Barrow is the economic, transportation, and administrative center for the NSB and the largest community, with a population in 2003 of 4,429, up from 2,267 in 1980 and 3,469 in 1990. The city was incorporated as a first class city in 1959. Most Barrow homes are heated by natural gas from nearby gas fields. Utilities are available through Barrow Utilities and Electric Cooperative. The community has schools including a community college, stores, hotels, police and fire stations, and a bank. Transportation to and from Barrow is provided by the Wiley Post – Will Rogers Regional Airport, including jet service.

The village of Anaktuvuk Pass was settled in the 1940s. The inland Nunamiut Eskimos were nomadic and largely vacated the Brooks Range area in the early 1900s due to a collapse in the caribou populations. By the 1940s, several Nunamiut families returned to the area and settled at the present village site. The community was incorporated as a second-class city in 1957. The village population has grown steadily, from 66 in 1950, to 134 in 1973, 203 in 1980, 259 in 1990, and 329 in 2003. Approximately 88% of the population in 2003 were Iñupiat. The village has a school and health clinic. In 2003, approximately 90% of the households had running water, up from only a quarter of the population in the late 1990s. Flush toilets have also reached 90% of the households thanks to recent completion of a water and sewer project by the NSB. Transportation to the village is provided by scheduled airline and charter service at the local airport.

The village of Kaktovik was incorporated as a second-class city in 1971. The village has a school, police and fire stations, water and sewer systems, a local store, and health clinic. The NSB provides all utilities. Just in the last decade running water has reached 90% of households. Transportation to the village is provided by scheduled airline and charter service at the local airport.

Table 4.7-A. Physical Size of the North Slope Villages Considered in the Cumulative Effects Analysis

Village	City Limits (acres)	Tracts (acres)
Kaktovik	620	149
Anaktuvuk Pass	3,302	373
Nuiqsut	5,760	649
Atqasuk	27,353	328
Barrow	13,866	3,028
Wainwright	9,222	1,022
Point Lay	Not Incorporated	1,576
Total	60,123	7,128

Table 4.7-B. Population of North Slope Villages within the Cumulative Effects Analysis Area

Village	1939	1950	1973	1980	1988	1990	1993	1998	2003
Kaktovik	13	46	144	165	227	224	230	256	284
Anaktuvuk Pass	NA	66	134	203	264	259	270	314	329
Nuiqsut	89	NA	128	208	314	354	418	420	416
Atqasuk	78	49	NA	107	219	216	237	224	250
Barrow	363	951	2,167	2,267	3,335	3,469	3,908	4,641	4,429
Wainwright	341	227	353	405	514	492	584	649	556
Point Lay	117	75	31	68	132	139	192	246	260
Total	1,001	1,414	2,957	3,423	5,005	5,153	5,839	6,750	6,524
NA – Not available.									

Projecting population growth is fraught with problems, particularly projections as far as the end of this century when we project that oil and gas production from the planning area will be reaching its end. For analysis purposes, however, we assume that population would grow for approximately the next forty years at a rate of 2% per year and then level off.

The estimate of the rate of growth is based on the population growth that occurred from 1988, by which time the major population influences of development of the giant Prudhoe Bay and Kuparuk oil fields had been realized, to 2003. The period from 1988 to 2003 represents a period of gradual expansion of oil and gas development. This development, primarily through tax revenues to the North Slope Borough and profits to local corporations, helped support a roughly corresponding growth of populations in North Slope Borough communities. As depicted in Figure 4-5 in **section 4.2.1.2**, under all of the alternatives oil production from the planning area reaches a rough plateau in the mid 2040s which persists until 2070 to 2090, depending on alternative. Falling oil production and a declining tax base related to depreciating oil infrastructure in existing fields could offset these economic stimulants to population growth, just as gas production and development of other new fields, both onshore and offshore, could reinforce these stimulants from development that may occur in the planning area. Depending on the amount of North Slope production that occurs during the middle and later parts of this century, population could continue to grow or begin to decline. For this analysis, however, we are assuming that these factors are roughly offsetting and that population growth would continue at the recent historic annual rate of 2% until almost the middle of this century (by which time the population would have approximately doubled) and then level off, perhaps declining at the end of the century.

Also, for our analysis we are assuming that growth in the population of communities will translate to approximately the same amount of growth in the land within communities that are developed for housing, commercial and government structures, and other community infrastructure. Based upon review of aerial photographs and consultation with the NSB, BLM estimates that approximately 1,800 acres have been occupied to date by community development. Assuming community infrastructure and footprint grow at roughly the same pace as population, there would be approximately 3,600 acres of community footprint by the time population may level off in the 2040s.

Military Development and DEW-Line Stations

The DEW-Line is an integrated chain of radar and communications sites stretching across Alaska, Northern Canada and Greenland. The DEW Line was initiated in 1954 when President Eisenhower signed a bill approving construction. Their purpose was to detect any incoming, over-the-pole, aircraft invasions emanating from the Soviet Union. Actual construction took place between 1955 and 1957 and the system was declared operational on July 31, 1957. A total of 58 sites were constructed; 22 of them were in Alaska, of these 14 were located along the coast of the North Slope (Table 4.7-C; www.lswilson.ca/dewline.htm#C accessed January 18, 2007).

Each DEW-Line site consisted of a gravel runway and road system, permanent housing, water and fuel storage tanks with pads, heating plants, and (petroleum/oil/lubricant [POL] and water) pipelines, garages, towers, and antennae. Military and civilian airlifts, sealifts during the summer, and cat trains distributed the materials to construct the permanent facilities. Land within the sites varied from 100 to 2,830 acres. There were three general types of stations, main stations (see Site Number column in Table 4.7-C), intermediate stations, and auxiliary stations. Main stations were larger and had more facilities and larger staff. Gravel runways were 5,000 feet long and 142 feet wide at main stations, 3,000 feet long at auxiliary stations, and 1,000 feet

long at intermediate stations. During operation, auxiliary sites had staffs of about 25 persons each, but main stations had 225 to 250 employees. Intermediate stations were not manned.

The DEW-Line program was discontinued in 1963. Most intermediate DEW-Line sites were closed at that time but were generally not restored until the late 1990s. The remaining stations (main and auxiliary DEW-Line stations) were subsequently converted to support the newer Northern Warning System (NWS) established in 1985. Alternating stations along the coastline were converted to long range (LRR) and short range radar (SRR) sites, respectively. The LRR stations were in operation by 1990, followed by the SRR stations in 1994. The LRR and SSR stations are still operating as of 2004. Some of these stations are still manned, but most were automated in the 1990s.

Abandonment, conversion, and automation left the stations with unused facilities. Clean-up and restoration of the stations occurred in the late 1990s and continues today. Many of the sites had contaminated soils or expected contamination consisting of petroleum, lubricants, PCBs, and insecticides, along with considerable volumes of debris and general refuse.

Table 4.7-C. DEW-Line Sites Constructed on the North Slope of Alaska

Site Name	Site Number[1]	Size (acres)	Present Status[2]	Current Operation[3]	NWS Established[4]
Point Lay	LIZ-2 (aux)	2,835	Closed	abandoned	1989/1990
Icy Cape	LIZ-B (int)	218	Closed	abandoned	NA [5]
Wainwright	LIZ-3 (aux)	ND[6]	SRR	automated	1994
Peard Bay	LIZ-C (int)	1,460	Closed	abandoned	NA
Point Barrow	POW-Main	268	LRR	manned	1989/1990
Cape Simpson	POW-A (int)	ND	closed	abandoned	NA
Lonely	POW-1 (aux)	2,830	Closed	abandoned	1994
Kogru	POW-B (int)	150	closed	abandoned	NA
Oliktok	POW-2 (aux)	2,325	LRR	manned	1989/1990
Pt. McIntyre	POW-C (int)	ND	closed	ND	NA
Flaxman Island	POW-3 (aux)	620	SRR	automated	1994
Brownlow Point	POW-D (int)	ND	closed	abandoned	NA
Barter Island	BAR-Main	4,500	LRR	ND	1990
Demarcation Bay	BAR-A (int)	100	closed	abandoned	NA

[1] Main = Main station; aux = auxiliary station; and int = intermediate station.
[2] LRR = Long Range Radar site, and SRR = Short Range Radar site.
[3] Current operations are manned, operational but automated, or abandoned – not in operation.
[4] Date Northern Warning System operations began at site.
[5] NA = Not applicable (station closed, not converted to NWS).
[6] ND = Not determined.
Source: Lackenbauer et al. 2005

Site clean-up of the Icy Cape Intermediate DEW-Line site was conducted in 1997 and included removal of two 20,000-gallon and six 300-gallon oil storage tanks, 800 feet of POL pipeline, a fuel pumping station, more than forty 55-gallon POL drums, a 240-feet unmarked tower, and 1,500 cubic yards of contaminated gravel fill. Soil sampling for potential PCB-contamination was conducted on the site in 2003. Future planned restoration activities include analyzing PCB soil test samples.

A Remedial Investigation and Feasibility Study (RI/FS) was conducted and identified six Installation Remedial Program sites at the Wainwright DEW-Line Station. The RI/FS determined the source and size of each of the Installation Remedial Program sites. Building Demolition and Debris Removal (BD/DR) activities are planned for 2008-2009.

Site clean-up (restoration) of the Peard Bay Intermediate DEW-Line site was conducted in 1997 and included the removal of a fuel pumping station, a 240-feet unmarked tower, and approximately 1,000 cubic yards of contaminated gravel fill on 5 acres. Soil sampling for additional petroleum-contamination and potential PCB-contamination was conducted on the site in 2003.

The DEW-Line Station at Point Barrow has three Installation Restoration Program Sites which are scheduled for environmental restoration beginning in 2008-2009.

Site clean-up of the Cape Simpson Bay Intermediate DEW-line site was conducted in 1998, and included removal of 12 (four 20,000-gallon and eight 300-gallon) oil storage tanks, two 1,000-gallon propane tanks, a fuel pumping station, 25 batteries, buildings, a 240-feet unmarked tower, POL-contaminated soil, a contaminated gravel fill, and POL-contaminated surface water.

Based upon historical usage and prior sampling events, 10 environmental impacted sites within the former Point Lonely DEW-line station have been identified as Areas of Concern. Major chemicals of concern are POL, PCB, general refuse, and insecticides.

Site clean-up of the Kogru Intermediate DEW-line site was conducted in 1996 and included removal of eight 300-gallon oil storage tanks and more than sixty 55-gallon POL drums. Additional soil sampling was conducted in the field to verify there is not petroleum or PCB contamination.

Seven environmentally impacted areas have been identified at the Oliktok DEW-Line Station. These areas are scheduled for restoration activities under Project Clean Sweep in 2007-2008. Major environmental concerns that have been identified at these areas are POL, PCB, general refuse, and insecticides.

Five environmental areas of concern, within the former Flaxman Island DEW-Line station, have been identified with possible POL, PCB, and general refuse contamination. Project Clean Sweep has scheduled major BD/DR activities at these sites for 2008-2009.

The Barter Island DEW-line station consists of 14 determined Installation Restoration Program sites. The U.S. Air Force's (611 Civil Engineering Squadron) Project Clean Sweep has scheduled major BD/DR activities for 2008-2009. Building/structure demolition and disposal and environmental background sampling are currently being conducted.

The Brownlow Point Intermediate DEW-Line site is currently abandoned. Most of the site has eroded into the Beaufort Sea. Site clean-up (restoration) conducted at the Brownlow Point site included the removal of one 25-feet by 80-feet unsafe building and more than 500 POL 55-gallon drums scattered over 10 acres. Due to low priority, no work is scheduled in the next 2 years. An associated 456-acre portion of the Brownlow Point site, known as Collinson Point, underwent initial site-cleanup (restoration) in 1994 and final clean-up in 2000. Removed from the site were 11 300-gallon to 550-gallon oil storage tanks, a fuel pumping station, a fuel pipeline, approximately 1,500 55-gallon POL drums, five buildings, a contaminated gravel fill, and

adjacent POL-contaminated soil. Planned future environmental activities include additional site visits to determine if contamination has been cleaned up so the site can be closed.

Site clean-up (restoration) of the Demarcation Bay (Nuvagapak Point) Intermediate DEW-Line site was conducted in 1994 and again (final clean-up) in 2000, and included removal of 19 oil storage tanks, 3,000 feet of petroleum/oil/lubricant pipeline, a fuel pumping station, five buildings, and more than 7,000 55-gallon POL drums. Additional soil sampling for petroleum and potential PCB contamination was conducted in 2003.

Restoration has taken place at Manning Point. This 10-acre site served as a staging area for the Barter Island DEW-Line station from 1952 to 1957, after which there was no follow-up use of the land. Restoration included removal of more than 10,000 55-gallon POL drums, 5 tons of combustible debris, and 25 tons of noncombustible debris. Planned future environmental activities include collection and analysis of additional soil samples so the site can be closed.

Griffen Point served as a staging area for several DEW-Line stations from 1953 to 1957. The site is currently abandoned. Restoration activities have included removal of more than 1,000 55-galllon POL drums scattered along 5 miles of the Arctic Ocean frontage.

4.7.2.2 Climate Change Overview

"....the only certainties in this assessment are that there are various levels of uncertainty in the projections and that even if an attempt is made to estimate the magnitude of these uncertainties, surprise responses of ecosystems and their species to changes in climate and UV-B radiation levels are certain to occur." (ACIA, 2005; p 249)

While climate change and its component impacts are reasonably foreseeable and thus included in the cumulative effects discussion, the uncertainty surrounding the direction and magnitude to say nothing of the timing inhibits the quantitative or qualitative addition of those effects to the cumulative whole. The discussions provided in this Supplemental IA/EIS are to provide the reader and decision maker with context and where possible suggest possible outcomes, i.e. many of the physical components of the ecosystem such as soils and coastal erosion may react in predictable ways, but even then surprises will emerge.

Change in global climate parameters is occurring at a rate and magnitude greater than any trend observed in the last 400 years. Change is disproportionately higher in the arctic (>60 degrees North Latitude, sensu; ACIA 2005) than in other regions. The proximate effects of climate change in the arctic are being expressed as increased average winter and spring temperatures and changes in precipitation amount, timing, and type (Serreze et al. 2000). These changes in turn result in physical changes such as reduced sea ice, increased coastal erosion, changes in hydrology, depth to permafrost, and carbon availability (ACIA 2005). These changes are resulting, or are expected to result, in changes to the biological environment, causing shifts, expansion, or retraction of home range, changes in behavior, and changes in population parameters of plant and animal species.

While it is possible to conclude in general terms that climate change will affect individuals, populations, and thus communities it is difficult to predict with any specificity how those effects will manifest themselves. The difficulties are related to uncertainty in feedbacks, thresholds, adaptation, resilience and component interactions (ACIA 2005, Hinzman et al. 2005) as well as substantial uncertainty around the models used to develop climate projections and the degree of

natural spatio-temporal variability in climate parameters characteristic of the Arctic (ACIA 2005).

Feedback to climate change can be positive (increasing the effects) or negative (decreasing or ameliorating the effects). Some feedback is already apparent. As warmer temperatures result in reduced sea ice extent, less solar heat is reflected by the ice cover and more is absorbed by the sea, resulting in increased rates of melting, which further reduce sea ice cover, resulting in more warming (Holland et al 2006). Additional positive feedback may come from the release of "greenhouse gases" (carbon dioxide, CO_2 and methane) from thawing permafrost and warming of ocean floors (ACIA 2005). Negative feedbacks could come from changes in salinity brought on by increased freshwater delivery to the ocean from ice melt and river discharge causing changes in ocean circulations and reducing heat transported to the arctic. Increased available carbon coupled with northward movement of tree species may result in increased atmospheric CO_2 uptake, reducing greenhouse gas. There is even the possibility that societal feedback will result in decreases in greenhouse gas emissions (GME), thus decreasing the anthropogenic addition implicated in global climate change (IPCC 2007).

Thresholds are lines that once crossed result in changes disproportionate to the increment that caused the threshold to be crossed. Climate change should not be expected to occur in a linear fashion with straight-line trends or smooth curves. Relatively abrupt changes should be expected as thresholds of resistance, resilience, and adaptation are crossed. Unfortunately thresholds are difficult to identify before they are crossed, and due to response time lags difficult to identify until some time after they have been crossed (Noon 2003).

Projected, near term (50-100 year) climate parameters fall within historic estimates. The latest occurring at the end of the Younger Dryas and lasting for about 1,300 years (ACIA 2005) with many switches between cold and warm phases of lower amplitudes and duration occurring in the intervening intervals between then and the present. Certainly many of the extant arctic species were present then and survived relatively unchanged to this period. These species survived either because they were resilient to change or they were able to adapt behaviorally or physiologically; most likely some measure of both. The mechanism(s) of adaptation those individual species used are largely unknown, as is the strength of the species resilience.

Individuals interact with the biological and physical components of the ecosystem they inhabit. Climate change may alter the strength and importance of those interactions in complex and unpredictable ways. Increased insect populations resulting from increased surface water and milder winters could increase insect harassment; however, predicted weather patterns may result in changes to predominant wind direction and increasing strength, thus suppressing insect flight. Earlier ice melt may increase nesting areas but changed environmental conditions may reduce nest success or overwinter survival. Coastal erosion, vegetation change or other factors may eliminate or reduce reproductive areas in one place but create it in another; however if that place is inaccessible or more easily accessible by predators it may have little or no value.

Because not all changes or all species will react to changing conditions at the same rate, some species populations will decline/increase to some new level, others may decline towards extinction dependent on their level or resistance to change or adaptive capability. What can be assumed is that if the current crop of climate projections are correct, species mix, richness, population size, and range will be different than today. For some species, change can be predicted with more precision than others based on observed trends, e.g. the increased terrestrial denning and eastward movement of female Southern Beaufort Sea polar bears likely

in response to changing ice condition (Amstrup or Regehr) may be expected to continue and it is likely that the worldwide population of polar bears will decline but whether they will continue to use the planning area, where and for what purpose is unknown.

Given the level of uncertainty of the impacts of climate change, attempting to determine the effects of oil development, whose scale and location are unknown, on individuals in the context of climate change is an exercise in speculation. Protected areas or reserves are of limited long-term value if the conditions within them are expected to change, possibly making them unsuitable or inaccessible. The only viable management response to climate change is to adopt desired outcomes and use adaptive management approaches to facilitate changes as warranted and possible to meet the desired outcomes.

4.7.3 Oil and Gas Exploration and Development Activities Considered in the Cumulative Effects Analysis

This section discusses the history and projects the future of development in the region by identifying past, ongoing, and reasonably foreseeable oil and gas activities in the planning area and elsewhere on the North Slope. Oil development is the main agent of industrial change on the North Slope. Oil and gas exploration and production activities have occurred on the North Slope since the early 1900s and production has occurred for more than 50 years. Associated industrial development has included the creation of an industry support community airfield at Deadhorse and an interconnected industrial infrastructure that includes roadways, pipelines, production and processing facilities, gravel mines, and docks. In 1977, the TAPS began to transport North Slope crude oil to a year-round marine terminal in Valdez, Alaska. Today, it continues to transport the North Slope's entire production, and it is projected to do so for many years into the future.

For this analysis, oil scenarios were developed based on estimates of future activities. The scenarios are conceptual views of the future that include the timing and extent of future petroleum activities in the Beaufort and Chukchi Seas and on the North Slope. Estimates of anticipated production consider many factors, including the conventionally recoverable resources of the area, past industry leasing and exploration efforts, and future economic conditions.

This cumulative impact analysis analyzes impacts of actions in the following categories:

- Past Exploration, Development, and Production: Exploration, development, and production activities and associated infrastructure for existing oil operations on the North Slope. This category involves construction and ongoing maintenance of present infrastructure, including support facilities and transportation systems.
- Present Exploration, Development, and Production: Exploration, development, and production activities that may be currently under construction or are currently undergoing agency approval process prior to construction. This category includes other non-oil-field development, including support and transportation components.
- Reasonably Foreseeable Future Exploration, Development, and Production: Exploration, development, and production activities, including support and transportation components, that would be associated with 1) extraction of discovered oil and gas that is not currently undergoing agency approval processes, or 2) discovery and extraction of the great majority of undiscovered oil and gas in areas with existing oil leases or for which land managers are planning to hold lease sales (BLM considers production of

approximately 88% of undiscovered oil within onshore areas to be a reasonable estimate for reasons discussed in **section 4.2.1.2**).

4.7.3.1 Past Exploration, Development, and Production on the North Slope and in the Planning Area

The North Slope of Alaska is a very sparsely populated region of extreme climate, with abundant energy and other natural resources. Exploration and industrial development for extraction of the mineral resources of the region (principally oil and gas), which has been active over the past 80 years, is the primary man-induced change to the North Slope (Table 4.7-D).

The most intense development activity to date occurred during the 1970s and early 1980s. It was during this period that the Prudhoe Bay and Kuparuk oil fields were developed, TAPS and the haul road (Dalton Highway) were constructed, and a large portion of the roads, drilling pads, gravel sources, collector pipelines, and production facilities were built. It was also a period of much activity in the NPR-A, with thousands of miles of seismic lines surveyed and dozens of exploratory wells drilled. Since then, additional North Slope development has occurred, but incremental physical disturbance to the environment has been reduced.

Table 4.7-D. Oil Exploration and Development on the North Slope

Date	Event
Before Recorded History	Visible oil seepages used by Native inhabitants of the North Slope.
1882	U.S. government representatives hear of oil seepages while traveling in the area.
1886	First non-Natives see seepages at Cape Simpson.
1901	Peters and Schrader traverse the Brooks Range and North Slope recording the geology and geography of the region.
1906-1914	E. Leffingwell mapped the Arctic Coast east of Barrow and much of the area that now comprises the Arctic National Wildlife Refuge.
1909	First description of Cape Simpson deposits published.
1914	First oil-related claim staked.
1921	Additional claims staked by individuals and industry.
1921	Large deposits of oil discovered in Oklahoma and Texas and industry loses interest in the remote Arctic.
1922	First industry-sponsored geological investigation of North Slope oil potential.
1923	Naval Petroleum Reserve No. 4 (PET-4) established.
1923-1926	First analysis of PET-4 potential.
1943	Territory of Alaska Bureau of Mines sends field party to the North Slope to investigate oil and gas seepages.
1944	Start of PET-4 petroleum exploration program; PET-4 headquarters established at Barrow; land north of the drainage divide of the Brooks Range withdrawn from pubic entry by the Secretary of the Interior; and Public Land Order 82.
1945	Thirty-one shallow core tests drilled at Cape Simpson and oil was produced.
1945-1952	Numerous geophysical studies conducted across PET-4 find oil and gas.
1947	Office of Naval Research establishes Arctic Research Laboratory.
1949	High sulfur, heavy oil found at a test well drilled near Fish Creek, and gas discovered near Barrow.
1953-1968	Federal geologic field studies continue in PET-4 and several major oil companies begin exploration.
1957	Oil discovered in Cook Inlet (south-central Alaska).
1958	Public Land Order 82 modified; Federal leasing begins on the North Slope; first industry-sponsored geological field programs; and Alaska Statehood Act passed.
1959	Alaska becomes the 49th state in the Union.
1962	First industry-sponsored seismic program.
1963-1967	First industry exploration well drilled on the North Slope; 11 unsuccessful wells drilled; and industry interest in the North Slope wanes.
1964	First State of Alaska lease sale on the North Slope.
1965	Area that eventually includes Prudhoe Bay leased.
1967	Initial exploratory drilling at sites that would become Prudhoe Bay field.
1968	ARCO announces the discovery of Prudhoe Bay oil field, the largest in North America.
1969	Kuparuk, West Sak, and Milne Point fields discovered; Alaska State Lease Sale No. 23 held; and Federal lease sales suspended on the North Slope for the next 10 years because the Secretary of the Interior imposed freezes due to Native claims.
1970	National Environmental Policy Act signed into law.

Date	Event
1971	Alaska Native Claims Settlement Act passed.
1974-1976	Federally-sponsored exploration along the Barrow Arch.
1976	PET-4 transferred from the Navy to the Department of the Interior and renamed the National Petroleum Reserve – Alaska; sale of crude oil from Petroleum Reserves 1, 2, and 3 authorized; and major exploration effort launched by the USGS in the National Petroleum Reserve – Alaska.
1977	Trans-Alaska Pipeline System operational.
1979	Initial leasing of portions of the state and Federal OCS waters of the Beaufort Sea.
1980	Alaska National Interests Land Conservation Act passed.
1981	First OCS exploration well drilled.
1982	Initial leasing of portions of the National Petroleum Reserve – Alaska.
1984-1985	Seismic exploration of the Arctic National Wildlife Refuge 1002 Area conducted.
1985	First industry exploration well drilled in the National Petroleum Reserve – Alaska.
1986	Arctic Slope Regional Corporation well drilled within the coastal plain of the Arctic National Wildlife Refuge.
Various times	Initial leasing of portions of Arctic Slope Regional Corporation lands.
Early 1990s	Last of the National Petroleum Reserve-Alaska leases from the initial leasing program are relinquished.
1994	Discovery of the Alpine field.
1998	Northeast National Petroleum Reserve – Alaska IAP/EIS ROD signed.
1999	Lease sale held in Northeast National Petroleum Reserve – Alaska.
2000	Alpine production begins.
2001	Northstar field begins production; development of Liberty field suspended; Phillips (successor of ARCO) announces discoveries in National Petroleum Reserve – Alaska.
2002	Lease sale held in Northeast National Petroleum Reserve – Alaska.
2003	Beaufort Sea Sale 186 held.
2004	Northwest National Petroleum Reserve – Alaska IAP/EIS ROD signed.
2004	Lease sale held in Northwest National Petroleum Reserve – Alaska.
2004	Alpine Satellite Development Plan EIS ROD signed.
2005	Beaufort Sea Sale 195 held.
2006	Northeast NPR-A Amended ROD signed.
2006	Startup of the Alpine satellite oil production pad known as Fiord or CD-3.
2006	Lease sale held in Northwest National Petroleum Reserve – Alaska.
2006	Beaufort Sea Sale 202 proposed.
2006	MMS Chukchi Sea Planning Area O&G Lease Sale 193 Draft EIS released.
2006	Startup of the Alpine satellite oil production pad known as Nanuq or CD-4.

Source: NRC (2003) and USDOI BLM (2006).

More recent fields have generally been developed in areas adjacent to existing producing areas, reducing the amount of additional support infrastructure (roads, pipelines, and processing facilities) needed to support additional production. At the same time, changes and improvements in technology have generally decreased the physical disturbance caused by more recent exploration, development, and production activities.

The following section discusses the history of exploration and development on the North Slope, and is summarized from information in NRC (2003) and in the Geology and Exploration of the NPR-A, 1974 to 1982 (Gryc 1988).

Pre-1900s

Oil seepages that are seen today along the Arctic Coast, from Skull Cliff on the Chukchi Sea to Brownlow Point on the Beaufort Sea, were the first evidences of potentially significant petroleum deposits on the North Slope of Alaska. Especially important were the active ponds of oil and layers of tar at Cape Simpson, just east of Barrow, likely known to the Native inhabitants long before recorded history. In 1881-1883, John Murdoch, a member of the U.S. Navy's International Polar Expedition, visited Point Barrow and vicinity, and in 1892 reported that the expedition heard stories of a lake of tar on an island a one-day sail east of Point Barrow, most likely Cape Simpson (Murdoch 1892). In August of 1886, the first non-Native people to see the Cape Simpson seepages could have been Charles Brower and his partner Patrick Grey while on a hunting trip (Brower 1942). The North Slope's potential as a significant oil province was further shown when Ensign W. L. Howard found a pebble-sized piece of oil shale along the Etivuluk River in 1886 (Smith and Mertie 1930).

1900 to 1940

In 1904, W. Peters and F. Schrader, a topographer and a geologist, published the first recorded systematic geologic and geographic traverse of the Brooks Range and the North Slope (Schrader and Peters 1904). In 1901, the researchers traveled by way of the John, Anaktuvuk, and the Colville rivers, naming and describing the Lisburne Formation of the Mississippian age and the Cretaceous rocks in the area. They noted the anticlinal structures in the foothills of the Brooks Range and numerous coal seams along the Colville and Anaktuvuk rivers. They also described the coal exposures along the northwest coast, which were mined by Alaska natives and whalers for many years.

From 1906 to 1914, E. Leffingwell mapped the Arctic Coast east of Barrow and much of the inland area of what is now the Arctic National Wildlife Refuge (Leffingwell 1919). He described and named the rock formations that were later discovered as the oil-bearing rocks at Prudhoe Bay and noted the seepages at Cape Simpson. He concluded that, "Even if an oil pool were found in the northern region, there is serious doubt of its availability under present conditions, though it might be regarded as a part of the ultimate oil reserves that would some time be developed."

From 1909 to 1921, individuals and industry representatives staked claims, under the extant mining laws, at Cape Simpson, Peard Bay, and along the Meade, Kukpowruk, and Kokolik rivers. During that time, large deposits of oil were discovered in Oklahoma and Texas and industry shifted their interest to those new places of production rather than the North Slope (Van Valin 1941).

About 1920, the U.S. Navy began to convert their engines from coal to oil, and an oil shortage was already being predicted. In 1923, in order to provide for the increased oil needs, the Naval Petroleum Reserve No. 4 (PET-4) was established by Executive Order No. 3797-1. The early

reporting of oil seepages at Cape Simpson, Ensign Howard's discovery of oil shale along the Etivuluk River, the description of resources found in the North Slope by Peters and Schrader, and Leffingwell's mapping of the area, were all used to decide on the borders of PET-4. However, the geology and the geography of the PET-4 interior areas were still largely unknown, and it was necessary to increase the level of mapping and data gathering on the area.

From 1923 through 1926, USGS parties crossed the Brooks Range and PET-4 and mapped the geology and geography along many of the larger rivers, including the Kuk and Utukok rivers in the west and the Etivuluk, Killik, and Colville rivers in the east (Smith and Mertie 1930).

The USGS team, P. Smith and J. Mertie, also analyzed the petroleum potential of the Reserve. They concluded that the best possible sources of petroleum were in the apparently widespread oil shales, while the sources of oil in the Paleozoic rocks were problematic. They did not believe the Cretaceous rocks held much potential for petroleum, as they thought the rocks were small and sparse. Additionally, they concluded that the Cretaceous source rock in the Brooks Range was too deep for practicable drilling. They recommended that evaluating the petroleum potential in the PET-4 would be best realized by drilling for stratigraphic and structural information near Cape Simpson, and then by pursuing additional geologic field studies and drilling in other favorable areas.

1940 – 1968
Government-Sponsored Exploration and Development Activities
In 1943, the Bureau of Mines sent a field party to the North Slope to investigate oil and gas seepages, in response to inquires from the Alaska Defense Command and Territory of Alaska officials. The field party examined and sampled the Cape Simpson seepages, as well as several additional sites along the Arctic Coast. Samples were collected from 12 separate sites, and seepages were confirmed along Skull Cliff, Dease Inlet, Cape Simpson, Fish Creek, Brownlow Point, Manning Point, and Umiat Mountain.

In 1944, the first modern program of exploration, drilling, and geophysical and geological surveys was started by the U.S. Navy, and USGS geologic traverses began along the Colville River, later expanding to all major north-flowing rivers of the North Slope. In 1946, overland travel was necessary for the detailed structural geologic mapping. Weasels, military-style tracked vehicles were used to cross the Brooks Range by four different routes, covering much of interior area of the PET-4. By 1950, almost every stream capable of floating by boat was also traversed. Helicopters were first used for geologic studies in the Anaktuvuk Pass area; aerial photographs of over 70,000 square miles of the PET-4 and adjacent areas helped geologists interpret the possible geologic structure of the area, and a special series of photos were also used to analyze and plan field surveys by the USGS.

Between 1945 and 1952, geophysical studies, including experimental airborne magnetometer and gravity and seismic surveys, were completed and covered a large part of the Reserve. The seismic surveys covered about 67,000 square miles, which included areas outside of PET-4, the gravity-meter surveys covered about 26,000 square miles, and the airborne magnetometer surveys covered 75,000 square miles, nearly all of the ACP and much of the foothills of the North Slope. Travel and housing of the geophysical crews was by tractor-sled trains, smaller tracked vehicles, and small aircraft.

In 1944, the first drilling locations were determined by the presence of the seepages at Cape Simpson and a reconnaissance of the Umiat Anticline. It was decided that drilling should be limited to depths less than 10,000 feet, thought to be the economic limit at the time. In

February and March of 1945, supplies were sledded to Umiat, where a drilling and logistic support camp was established and drilling began. The Umiat oil field, however, was not discovered until 1950, and still remains undeveloped. However, Umiat is still an important operating base for air transportation and geophysical and geological operations.

Also in 1945, 31 shallow core tests were drilled at Cape Simpson. Oil was produced, but the estimated reserves were considered too small to justify additional development. By 1948, geophysical surveys indicated the presence of a large basement high under the Barrow high and led to drilling near the top of the high. Gas was discovered, but neither oil nor hard rock basement was found at a depth of 2,500 feet. This area is now referred to as the Barrow Arch, the north limb of the Colville Basin.

In 1949, high sulfur, heavy oil was found at a test well drilled near the Fish Creek seepage at a depth of 3,000 feet. However, no structure was found and no reserve estimate was made, and continued geophysical exploration around the Barrow high found no significant oil reserves. Given the discovery of oil at Umiat, and the mapping of several closed anticlinal structures in and adjacent to PET-4, it was thought that further potential was in the northern foothills. Therefore, 10 shallow test holes were drilled on 6 structures; 1 gas field and 3 prospective gas fields were discovered; and 2 closed structures were mapped in the western part of PET-4. Test wells were drilled, one, Meade, of which showed strong gas, and one, Kaolak, of which was dry.

From 1945 through 1952, 45 core tests and 36 well tests were drilled within and adjacent to PET-4. The results showed one large oil field, Umiat, one large gas field, Gubik, one small gas field, Barrow, three prospective gas fields, Mead, Square Lake, and Wolf Creek, and two small oil deposits, at Cape Simpson and Fish Creek.

In 1947, the U.S. Navy, Bureau of Yard Docks, established and developed a research facility in the Seabee (Navy Construction Battalion) detachment, at Barrow. This was an important development for the Barrow community and for the exploration and development of the North Slope petroleum reserves. By May of 1947, a building program began to provide housing and laboratory facilities for the Arctic Research Laboratory (ARL), Office of Naval Research (ONR), and in August of 1947, ONR occupied these new facilities. To more fully acknowledge the U.S. Navy's contribution to Arctic research, ARL became the Naval ARL (NARL) in the mid-1960s.

In 1949, the discovery of gas at Barrow was likely the most significant result of the PET-4 project to the people of Barrow. The South Field is the oldest producing gas field in Alaska and the South and East Gas fields are the farthest north producing oil or gas fields in North America. When the PET-4 project arrived in 1944, Barrow was home to about 400 inhabitants; the exploration activities provided employment opportunities for the local people and the population quickly increased.

In 1953, the PET-4 program was unexpectedly halted. By then, additional drill sites had been selected and supplies had started to arrive at a location east of PET-4, in the southern foothills near the head of the Shaviovik River and at another location at the head of the Utukok River in the southwest corner of the Reserve. Most of the supplies were later returned to Barrow and Umiat.

In 1964, Congress granted permission to extend the gas supply to Barrow, and the village was completely converted to natural gas by 1965. The gas was supplied by the U.S. Navy at a subsidized cost and use was unlimited, which the Barrow community was dependent on for heat and power.

After the PET-4 program was recessed in 1953, the entire camp facility was turned over to ONR until December 1954, when the Air Force took over the management of the base camp to support the DEW-Line program. The Air Force continued to operate the base camp through civilian contractors until October 1971, when the operation was returned to the U.S. Navy. During that period, ONR continued to manage the laboratory through a contract with the University of Alaska.

In 1980, the NARL was decommissioned and the camp and all facilities were turned over to the USDOI. From 1980 through 1984, the laboratory and camp facilities were managed by the USGS and their contractor, primarily as a base of operation for the Barrow Gas Fields. In 1984, NARL and the base facilities were tuned over to the local Native corporation, Ukpeagvik Iñupiat Corporation (UIC).

State and Federal Leasing and Industry-Sponsored Exploration Activities

In the mid- to late 1950s and early 1960s, a number of factors led to the beginning of industry actively exploring the North Slope for oil and gas resources. Although industry was aware of and interested in the North Slope, the lack of land availability, remoteness, and high costs associated with operating in the area had previously precluded industry participation.

The factors that contributed to the entry of industry into the North Slope exploration scene were an overall encouragement of regional geological studies, the PET-4 program, the discovery of commercial quantities of oil and gas in Cook Inlet, and the end of the land availability moratorium on the North Slope, the latter of which was likely the most important factor in attracting industry to the area. The oil and gas found in the Cook Inlet demonstrated that it was economically feasible to explore for, develop, and sell hydrocarbons in and from Alaska. In 1957, ARCO made the initial discovery of Alaskan oil at Swanson River, on the Kenai Peninsula, which contributed significantly to Alaska statehood in 1959 and provided incentive to industry for the exploration of other sedimentary basins in the state.

After the Federal government's decision, through BLM, to make lands available for leasing, a total of 18,862 leases were offered in sales held in 1958, 1964, 1965, and 1966 (Jamison et al. 1980). Most of the sales were to the east and southeast of PET-4, however the lease sale in 1966 contained 3,022,716 acres to the west of PET-4.

In addition to the Federal government lease sales, the State of Alaska selected 1,616,745 acres across the northern tier between the Colville and Canning rivers, to be offered for lease between 1964 and 1967. In 1964, the State's first lease sale on the North Slope offered 650,000 acres in the Colville River Delta area, and 196 tracts totaling about 475,000 acres were leased. In 1965, the State's second North Slope lease sale offered 754,000 acres, and 151 tracts totaling 380,000 acres were leased. Richfield-Humble acquired 28 blocks on what is now the crest of the Prudhoe Bay oil field, and British Petroleum acquired 32 blocks on the flanks. During the third State lease sale, in 1967, Richfield-Humble acquired 7 of the 13 tracts offered and leased; the 7 tracts covered the remainder of the crestal area of the Prudhoe Bay field.

In 1958, Sinclair operated a 3-month field program out of Umiat in preparation for the Federal lease sale that year. In order to gain a better understanding of the subsurface geology and the hydrocarbon potential of the region, many companies began to gather geological data during summer field programs and geophysical, primarily seismic, during winter seismic operations. Following Sinclair, an average of five to seven companies were in the field during the 1959 through 1961 seasons, and up to 10 companies per year were operating geological field

programs from 1962 through 1964. Field programs began to decline after 1964 and only two or three companies were in the field per year.

In 1962, Sinclair and BP operated the first industry program, with the first seismic season consisting of about 6.5 crew-months. The crew-months grew to about 29 in 1963, peaked at about 53 in 1964, and decreased to about 27 in 1965. There was little seismic acquisition between 1965 and 1968, until the season following the Prudhoe Bay discovery (discussed below).

In 1963, industry began exploratory drilling, based on leasing, geologic field work, and seismic acquisition. A total of 11 dry wells were drilled between 1963 and 1968. Colorado Oil and Gas Company drilled in the Gubik area, followed by seven other private wells, all of which were drilled on leases acquired in the first round of Federal lease sales. No discoveries were made. The wells were located in the foothills, within 30 miles of either the Umiat or Gubik discoveries, near the areas that had shown the most promise during the Navy's previous exploration efforts.

After the initial failure of the drilling programs in the Umiat-Gubik area, industry shifted efforts to the north and east areas of the North Slope. During 1966 and 1967, Sinclair and Union each drilled a well on the eastern flank of the Colville High; both wells were dry. During the same period, ARCO-Humble drilled another dry well, Susie No. 1, in the northern foothills of the Brooks Range. The decision was made to take the rig 60 miles north to drill in the Prudhoe Bay area, rather than releasing the rig and ceasing any further drilling.

In April of 1967, drilling began for Prudhoe Bay State No. 1. In January of 1968, ARCO-Humble announced the discovery of oil and gas with a recoverable economic reserve estimate of 9.6 Bbbl of oil and 26 Tcf of gas.

At this time, there were little to no geologic and seismic programs on the North Slope and, other than Prudhoe Bay State No. 1, all drilling activity had ceased. However, with the discovery at Prudhoe Bay, and the State's announcement for an additional lease sale in the fall of 1969, industry substantially increased the level of exploration activities on the North Slope. The geological and geophysical programs surpassed the 1967 levels to 12 geological crew-months and 24 seismic acquisition crew-months in 1968 and 20 and 97 crew-months, respectively, in 1969 (Jamison et al. 1980). Additionally, in 1969, several other oil accumulations were discovered: the Kuparuk, West Sak, and Milne Point fields.

In September of 1969, the Alaska State Competitive Lease Sale No. 23 was held, offering 179 tracts totaling 450,858 acres–the unleased portion of the State's 1,600,000-acre allotment for the Statehood Act. With an average price per lease of $2,181.66 per acre, high bids on the 164 of the 179 tracts totaled more than $900,000,000. This was the last sale on the North Slope for 10 years (ADNR 2001a).

1969-2007

Between 1969 and 1979, there were no additional lease sales held on the North Slope or the adjacent waters of the Beaufort Sea, making land accessibility the limiting factor for industry activity. Beginning in 1979, however, the shallow State waters and Federal OCS areas of the Beaufort Sea were made available through a series of lease sales, and additional onshore sales were held in the Colville-Canning area. The State offered 71 tracts (341,140 acres) and granted leases on 62 tracts (296,308 acres). This sale marked the first major venture into offshore leasing in the Arctic by either the State or Federal governments. The State continued to offer lease sales through the 1980s and 1990s. The State of Alaska has offered areawide sales on the Beaufort Sea since 2000, with their latest lease sale in 2006. The tracts offered are located

within the North Slope Borough and consist of State-owned tide and submerged lands in the Beaufort Sea between the Canadian Border and Point Barrow. The 2006 sale received bids on 76 tracts for approximately 231,680 acres, which was twice the acreage received in 2004 covering 113,570 acres. To date, approximately 21 tracts are leased in Harrison Bay, east of Lake Teshekpuk, and 31 tracts have been leased in the Smith Bay area, northwest of Lake Teshekpuk (ADNR 2006).

In the 1980s, 1999, 2002, 2004, and 2006 the Federal government, through BLM, opened portions of the NPR-A to leasing. The Arctic National Wildlife Refuge has not been open to leasing, although there are Native inholdings, and a land trade with Native corporations was considered in the mid-1980s. Also, at various times, the ASRC made portions of their lands available to companies under exclusive exploration/leasing agreements.

Table 4.7-E lists the discoveries, date of initial production, and 2005 production and reserves for oil and gas fields on the North Slope. Individual oil pools have been developed together as fields that share common wells, production pads, and pipelines. Fields have been grouped into participating areas (or production units) sharing common infrastructure, such as processing facilities, roads, and pipeline systems. Table 4.7-F provides information on the existing infrastructure. A map showing the location of these developments and the general infrastructure interconnecting them is shown in Map 3-2. All of these fields, with the exception of Northstar, Endicott, Sag Delta North, and Eider, are onshore on state leases. The Niakuk, Point McIntyre, and Badami oil pools are mainly offshore, but are produced from onshore sites. If the Point Thomson field, which is included in the list of future projects, is developed, it is expected that the proposed Point Thomson pipeline would tie into Badami's common-carrier pipeline. In 2005, Exxon Mobil was found to be in default for delaying development of Point Thomson by submitting a plan without any sure date for production to begin. In November 2006, the Point Thomson leases were revoked due to Exxon Mobil's lack of a viable plan to develop the oil and gas prospect, although litigation has been initiated to reverse this decision. Over the last three decades, Exxon Mobil has filed 22 development plans for the 106,200 acre Point Thomson unit with no commercial oil or gas operations conducted to date. The revoked leases will be reoffered pending resolution of the current litigation. (Associated Press, 2006).

The following discussion of the post-Prudhoe Bay activity focuses on four geographic areas that have different degrees of accessibility and economics. These are the Colville-Canning area/shallow State waters, the Beaufort Sea OCS, National Petroleum Reserve - Alaska, and the 1002 Area of the Arctic National Wildlife Refuge. The onshore areas frequently contain some combination of state/Native or Federal/Native land ownership.

Colville-Canning Area/Beaufort Sea State Waters

Through the 1970s, the area between the Colville and Canning rivers, from the Beaufort Sea south to the Brooks Range, was the sole area of industry exploration on the North Slope. Because of limited land availability and the success at and near Prudhoe Bay, this area has been the focus of exploration activity since the discovery well was drilled in 1968. The bulk of exploration and drilling has been concentrated in the northern portion of the area, near Prudhoe Bay and east and west along the coastline, following the structural trend of the Barrow Arch. The State leasing program that began in 1979, in the shallow state waters of the Beaufort Sea, is generally confined to a 3-mile-wide strip seaward from the shoreline and from Barrow to the Canadian border. The issue of ownership becomes somewhat irregular in the vicinity of the barrier islands and major inlets.

Seismic activity was at a high in 1970 with 96 crew-months. This decreased to 8 crew-months in 1972, and then grew back to 54 crew months in 1974. Following the high level of activity generated by the Prudhoe Bay discovery, geological and geophysical crew activity decreased sharply in the early 1970s and then slowly increased and stabilized to 25 crew-months by the late 1970s. In the early 1970s, geological field programs averaged about 20 crew-months per year. By 1974, this decreased to 6 crew-months and averaged 5 to 6 crew-months through the remainder of the 1970s (Jamison et al. 1980). During the 1980s and 1990s, the amount of fieldwork varied considerably, but the activity never reached the levels seen in the 1960s and 1970s. Over the last decade, geological activity has averaged 1 to 3 crew-months per year. Unlike seismic acquisition and exploration drilling, geological field activity frequently takes place external to the principal area of exploration interest. Much of the fieldwork was carried out in the Brooks Range to the south and in the Sadlerochit and Shublik Mountains of the Arctic National Wildlife Refuge.

Since 1980, the level of seismic acquisition has varied, but likely averaged less than 20 crew-months per year. One of the major reasons for this decrease has been the departure of several companies and the merger of former competitors. Also, the existing regional seismic grid was found to be of sufficient quality to allow companies to more finely tune their seismic acquisition and focus on specific areas. The more recent seismic acquisitions tend to be 3-D programs that provide a more detailed image of the subsurface than do the 2-D surveys. Seismic 3-D programs are too costly to be acquired on a truly regional scale and are generally limited to a maximum of 500 to 600 square miles.

From 1970 to the present, there have been at least 35 discoveries on state lands (ADNR 2001b). These range from the currently uneconomic Kavik (discovered in 1969) and Kemik (discovered in 1972) gas fields in the east-central portion of the Colville-Canning province to large oil discoveries at Endicott (discovered in 1978) and Alpine field (discovered in 1994). A significant undeveloped resource is the Point Thomson oilfield (discovered 1977) . The field is located just to the west of the mouth of the Canning River and contains reserves estimated at 5 Tcf of gas and 360 MMbbl of oil.

Twenty-five of the 35+ discoveries are either developed and on production, or are currently being developed (i.e., Northstar, located offshore). At least seven or eight of the discoveries are satellite fields and would not have been developed if they were not adjacent to a large field with an existing infrastructure. Tabasco and the Midnight Sun/Sambuca fields are satellites, each of which has oil reserves of 30 to 70 MMbbl.

The most recent fields to be developed in this region are associated with the Alpine oil field. The Alpine oil field and satellite developments encompass approximately 890,000 acres of Federal, state, and private lands in the central ACP of the North Slope. This area includes the Colville River Delta and the portions of the Tingmiaksiqvik River, Judy Creek, Fish Creek, Kalikpik River, and Kogru River drainages in the easternmost part of the planning area. During 1996, ARCO announced that the Alpine Prospect in the Colville River Delta was producible and contained an estimated 365 MMbbl of oil. More recent estimates of Alpine oil field reserves, however, are near 500 MMbbl. In November of 2000, production began in the Alpine field. Combined production from the original Alpine field (CD1 and CD2) and the two satellite fields (CD3 and CD4) is expected to peak at 135,000 BOPD in late 2007. Oil handling and seawater injection facilities were expanded in 2004 to allow for 140,000 BOPD.

Alpine field oil reserves are extracted from four production pads (CD-1 through CD-4). The CD-1 pad serves as an oil processing facility and is connected to CD-2 by a 3-mile long road.

Infrastructure at the existing CD-1 pad fully supports the ongoing drilling and production operations, including activities at the CD-2 field and satellite fields (CD-3 and CD-4). Oil is transported back from the satellite pads to the central processing facility at CD-1 through utility pipelines. Facilities and equipment currently installed include processing facilities, production wells, camp facilities, sanitation utilities (water and wastewater), a drilling mud plant, an airstrip, a maintenance complex, warehouse buildings, disposal wells, an emergency response center, and communications, power generation, and various mobile equipment (USDOI BLM 2004c). Oil is transported through a 34-mile pipeline to a CPF in the Kuparuk River Unit, where Alpine field oil production is commingled with that of other fields in the area. Alpine field oil is then transported via the main Kuparuk River Unit pipeline to Pump Station 1 of TAPS. The Alpine oil field pipeline to the Kuparuk River Unit crosses under the Colville River channel. Ice roads and bridges provide access during the winter; otherwise there are no overland routes to this isolated field. There are no gravel roads connecting the road system in Kuparuk River Unit to the Alpine oil field. The footprint of the Alpine oil field infrastructure, excluding the pipeline to the Kuparuk River Unit, is approximately 170 acres.

Since the first commercial discovery at Prudhoe Bay in 1968, at least 35 discoveries have been made on State leases and 25, nearly all in the immediate Prudhoe-Kuparuk area, were or are being developed. With existing infrastructure in place, this area has been, and will continue to be, the primary exploration ground for oil and gas.

Federal OCS and Beaufort Sea

The Beaufort OCS was unavailable to industry until the joint State of Alaska/Federal lease sale of 1979, which, along with subsequent sales, provided access to waters beyond the 3-mile limit, stretching from Point Barrow in the west to the Canadian border in the east. Including the 1979 lease sales, the Beaufort OCS has been the site of at least nine lease sales over a 26-year period (USDOI MMS 2005). The most recent sale, Sale 202, was held in April 2007. Over 800 leases have been issued in the Beaufort Sea, totaling over 3.7 million acres. Additional lease sales are scheduled for 2009 and 2011 (USDOI MMS. 2006e).

The data acquisition issue is somewhat different in the case of the OCS regions. There is little or no geologic field work conducted exclusively for the purposes of developing a better understanding of the offshore subsurface geology. Rather, the subsurface well control from onshore drilling activities and secondarily outcrop geology is tied into the seismic grids to extend the geologic interpretations into the offshore areas and assist in the definition of potential prospects.

Seismic acquisition in the OCS is not well documented; however, commencing in the mid- to late 1970s, both summer marine and winter ice programs were acquired to correlate the better explored and understood onshore geology into the Beaufort Sea. Most, if not all, of the existing seismic data are 2-D, with little if any 3-D acquisition outside of the areas of existing discoveries or prospects that are being prepared for drilling within the next few seasons. While the per season or total line miles are not known, the totals are easily in excess of 5,000 line-miles. In summer 2006, roughly 6,500 kilometers of 2D seismic survey were collected along the northern coasts of both Alaska and Canada.(Petroleum News, 2006b).

The existing seismic grid extends across state waters and ties into onshore wells or wells in the shallow near-shore portions of the Beaufort Sea. The acquisition area extends from near Point Barrow on the west to near the Canada border on the east.

The first OCS exploration well was the Beethy Point No.1 in 1981, and the most recent exploration well was the McCovey No. 1 in 2002. The peak of exploration drilling was in 1985 through 1986, when 11 of the 30 exploration wells were drilled. A secondary drilling phase occurred during 1991 through 1993, when seven wells were drilled.

Depending on water depth, the OCS exploration wells are either drilled from man-made ice islands or large, heavy, bottom-anchored, ice-resistant drilling rigs. If a discovery is made and the field developed, a more permanent structure is built to provide the base for long-term operations.

Eleven of the OCS exploration wells are determined to be capable of production (USDOI MMS 2001b). Of these, five are termed significant discoveries, of which four are in the OCS waters: Tern/Liberty (discovered in 1983), Hammerhead (discovered in 1985), Sandpiper (discovered in 1986), and Kuvlum (discovered in 1992). The fifth well is the Northstar field (Seal well), which underlies both Federal and state acreage (ADNR 2000, USDOI MMS 2001b).

Tern/Liberty, Sandpiper, and Northstar lie offshore from the well-established Kuparuk and Prudhoe Bay fields and their infrastructure. The Hammerhead and Kuvlum discoveries are well to the east of the Prudhoe Bay field, in relatively deep water. Hammerhead is offshore from the Point Thomson and Flaxman discoveries. The Kuvlum discovery is to the east of the Canning River and offshore from the 1002 Area of the Arctic National Wildlife Refuge. The Northstar field has been developed and began production in late 2001.

Federal OCS and Chukchi Sea

The Chukchi OCS area has been offered previously in 1988 and 1991. The 1988 sale offered 4,694 lease blocks with a total of 25,631,122 acres, leasing 350 lease blocks for a total of 1,976,912 acres. The 1991 sale offered 3,476 lease blocks with a total 18,987,976 acres, leasing 28 lease blocks for a total of 159,213 acres (USDOI MMS, List of Alaska Region Lease Sales. September 2006). There have been no active leases in the Chukchi since 1998. Proposed lease sale 193 (initially planned for 2007, but currently delayed), differs from the previous sales in that a 25-mile buffer has been added along the coast making those lands unavailable for leasing. Additional lease sales for the Chukchi are planned for 2010 and 2012.

Five exploration wells were drilled from 1989-1991 (Diamond, Popcorn, Crackerjack, Burger, and Klondike), with the Burger well having a significant gas show (approximately 14Tcf and 724 MMbbl of condensate (USDOI MMS, 2001d). No additional wells were drilled to delineate the prospect. No development has taken place.

In summer 2006, roughly 6,500 kilometers of 2D seismic survey were collected along the northern coasts of both Alaska and Canada (Petroleum News, 2006b).

National Petroleum Reserve – Alaska

In 1974, the high prices of oil and the discovery of oil at Prudhoe Bay renewed interest in PET-4. The U.S. Navy began a small exploratory program, and in 1975, the Navy awarded a 5-year contract to Husky Oil, Inc., to manage and conduct a full-scale petroleum exploration program in PET-4. The focus of the exploration work was in the northeastern portion of the Reserve where it was believed that it would be most likely to encounter an extension of the Prudhoe Bay productive zones.

In 1976, PET-4 was renamed the National Petroleum Reserve – Alaska, oversight of the Reserve was transferred from the Navy to the USDOI, and the USGS was assigned several tasks, including (1) continuing the program of exploration begun by the Navy, (2) continuing operation and management of the Barrow gas fields, and (3) completing the cleanup program, begun by the Navy, of the Reserve and adjacent areas. Between 1974 and 1982, 28 test wells were drilled, and although indications of oil or gas were found in nearly all of the test wells, no deposits were found that warranted development. In addition, six exploratory and development wells were drilled in the Barrow area to supplement the local gas supply. Exploratory drilling by the USGS ended in 1981 when the NPR-A was opened up to leasing.

Nearly 15,000 miles of seismic survey was completed and interpreted between 1974 and 1982. Seismic activities covered 1,440 miles in 1976. In 1977, seismic surveys covered approximately 1,500 miles, primarily in the Foothills Province; this area and the Brooks Range were again explored in 1978 when 1,916 miles were surveyed. In 1979, 1,900 miles of seismic survey was obtained, including use of the Vibroseis method, rather than explosives. Much of the work was focused in the foothills area between Umiat and the western boundary near Icy Cape. In 1980, 1,096 miles of seismic surveys were run, with one party in the coastal area and the other in the foothills and Brooks Range. Most of these surveys were for fill-in reconnaissance. During 1980 and 1981, seismic activities slowed, as it became apparent that Congress would open the NPR-A to private exploration, which occurred in December 1980.

The Federal leasing program in the NPR-A commenced in 1982 with two lease sales in January and May. Most of the acreage was located in the south and southeastern portions of the NPR-A. A total of 271 tracts, totaling 5,035,772 acres, were offered in the two sales, and 38 tracts, totaling 927,965 acres, were leased. The leased activity was focused in the areas west of Nuiqsut, west of Umiat, and west of the Lisburne well. In both sales, the lessees appeared to be pursuing Umiat play-types. In July of 1983, a third sale was held, where 84 tracts and 2,195,845 acres were offered, spread across the northern portion of the NPR-A; 20 tracts, totaling 419,618 acres, were leased (USDOI BLM 1990b). These tracts appear to have been selected to evaluate Prudhoe Bay play-types and were largely concentrated in the area between Admiralty Bay and the Chukchi Sea. A fourth sale was scheduled for July 1984, but was cancelled after no bids were submitted on the 64 tracts and 1,550,677 acres offered (Weimer 1987, Banet 1991).

The leasing in the early 1980s resulted in the drilling of only one industry exploration well within the NPR-A, located in the western portion about 40 miles south-southwest of Point Barrow. The hole was dry and all other plans to drill were abandoned.

After the discontinuance of leasing in 1984, a 15-year hiatus in leasing activity and exploration in the NPR-A took place. It was not until after the 1994 discovery of the Alpine field in the Colville River Delta area that the government recognized the renewed industry interest in the NPR-A. After the discovery of the Alpine field, and in preparation for pending sales in the NPR-A, the major participants in ongoing North Slope exploration began to conduct 2-D and 3-D seismic programs in the probable sale area. The total line-miles of seismic data acquired are not known. There were at least seven 2-D programs acquired between 1992 and 1997 totaling 2,615 line-miles. A single 3-D program was shot in 1996 and covered an area of 152 square miles (Konbrath et al. 1997). There were additional 2-D and 3-D programs acquired since 1997; however, the number of programs and coverage are not known.

BLM re-instituted leasing in the Northeast NPR-A in May 1999. Approximately 3.9 million acres were offered, drawing 133 high bids on 867,721 acres. The bulk of the leased areas are in

the vicinity of Nuiqsut and between Teshekpuk Lake and the Ikpikpuk River. After the 1999 sale (Sale No. 991), the industry began a drilling program in the northeastern portion of the NPR-A. Three wells were drilled in the winter of 2000, six wells were drilled in 2001, and an additional four wells were drilled in 2002. Most, if not all, of these wells were probably targeting Alpine-style prospects. An additional sale was held in 2002, where a total of 60 tracts with 579,269 acres were leased. This leased acreage is generally to the south and west of previously acquired leases. Subsequent to the 2002 sale, eight wells were drilled over the next four years, all but one in Northeast NPR-A. Four wells were drilled in the 2007 winter season, one of which was in the Northeast NPR-A. The remainder of the wells are located in the Northwest NPR-A planning area.

Following signing of the Northwest IAP/EIS ROD, BLM held a lease sale in 2004 for 484 tracts of land within the Northwest NPR-A and another 22 tracts that are combinations of Northwest NPR-A and planning area lands, totaling approximately 5.8 million acres. Bids were received on 123 of the tracts, totaling 1,403,561 acres. Another lease sale was held for the Northwest NPR-A in 2006. The sale offered 478 tracts totaling 5.4 million acres. Bids were received on 81 tracts totaling approximately 940,000 acres.

At least five of the post-1999 exploration wells drilled in the NPR-A have discovered oil and/or gas. The sizes of the discoveries have not been made public, but the operators have indicated that the oil reserves are at least equal to those of the Alpine field.

Arctic National Wildlife Refuge

The Alaska National Interest Lands Conservation Act (1980) established the Arctic National Wildlife Refuge (ANWR). In Section 1002 of that Act, Congress deferred a decision regarding future management of the 1.5-million acre coastal plain (1002 Area) in recognition of the area's potentially enormous oil and gas resources and its importance as wildlife habitat. A report on the resources (including petroleum) of the 1002 Area was submitted in 1987 to Congress by the USDOI. The 1002 Area of the Arctic National Wildlife Refuge has numerous active oil seeps, exposures of oil-stained sandstone, and large attractive structures. However, these lands are currently closed to industry and can only be opened for exploration and potential development by an act of Congress.

Because ANILCA prohibits it, there has been no leasing in the 1002 Area. However, in 1987, the Reagan administration proposed to trade land/exploration rights in the 1002 Area for Native corporation inholdings in National Parks and other sensitive areas. Six Native corporations were found qualified to participate and each chose an industry partner. The industry partners were to supply technical expertise and have exclusive right to explore any lands acquired by their Native corporation partners.

The Federal government proposed and developed a tract selection/trade process and the Native corporations and their industry partners proceeded to bid on 71 complete or partial tracts; tracts were 4-square-mile parcels. Virtually all the prospective trade lands identified in the process were either along or to the east of the Marsh Creek Anticline. Unpublished industry evaluations tended to place a greater portion of the areas potential resources in the deformed area, including the Marsh Creek Anticline and areas to the east. This land trade, however, was never carried through to completion, nor were the lands transferred.

Data acquisition in the ANWR has been largely restricted to geological field parties in the Brooks Range, south of the 1002 Area, and to the limited seismic acquisition program conducted

under government oversight in 1984 and 1985. These two seasons produced approximately 1,400 line-miles of mostly poor to moderately good data quality.

Since there has been no leasing within the 1002 Area, there has been no exploration drilling. However, Kaktovik Iñupiat Corporation holds surface title to some lands, and the city of Kaktovik lies within the boundaries of the refuge. British Petroleum/Chevron drilled a well on Native lands through an exclusive exploration agreement with the Native corporation. The information from this well is held in confidentiality since it was drilled in 1986.

Furthermore, since there has been no drilling within the 1002 Area, there have been no discoveries. There were two discoveries, however, west of the Canning River that abut the 1002 Area. It is possible that either the Sourdough or Point Thomson fields may extend eastward into the 1002 Area. If and when they are developed, they may have the potential to drain oil and/or gas from beneath the Arctic National Wildlife Refuge.

Native Corporation Lands

The ASRC and its various village corporations have extensive land holdings across the slope. These extend from Barter Island in the east to the Chukchi Sea in the west and from the Beaufort Sea in the north to the crest of the Brooks Range in the south. The regional corporation and several of the village corporations have entered into exploration agreements with various petroleum companies. These agreements have generally required some form of initial monetary commitment, specific work commitments, and an agreement to lease potential acreage or forfeit the right to explore at an agreed upon date. One or more exploratory wells are also required if the company elects to go to lease.

There is no competitive leasing process utilized to make lands available to industry. The negotiations are generally confidential. Chevron, Texaco, ARCO, and Unocal have had such agreements in the past. Anadarko Petroleum and its partners currently have an exclusive exploration agreement with ASRC for nearly 3 million acres in the foothills of the Brooks Range.

The data acquired on Native corporation lands, especially seismic and geophysical data, are usually kept confidential, with the data only available to the corporation and its industry partners. However, with the recent interest in a gas pipeline, there is increased activity in the Brooks Range foothills, and the Native corporation lands are being reevaluated for both oil and gas. This has resulted in a recent increase and refocus of geologic field efforts in the foothills belt. Similarly, new seismic data were acquired during recent winter seasons. These seismic programs included both 2-D and 3-D acquisition technologies.

Through ASRC's exploration agreements with various companies, exploration wells have been drilled on Native corporation lands on the North Slope (ADNR 2001b). Some of these Native corporation holdings are in the form of inholdings within national parks, national monuments, and wildlife refuges. This has afforded those companies with Native corporation exploration agreements the opportunity to drill and evaluate areas that are not otherwise accessible and are off limits to the rest of the industry. These wells were drilled on inholdings within the Arctic National Wildlife Refuge and the NPR-A, as well as in the foothills of the Brooks Range south of the state acreage in the Colville-Canning area. There were also wells drilled on ASRC lands to the west of the NPR-A, and there was one discovery associated with ASRC lands in the Colville River Delta. The Alpine field extends beneath leases jointly held with the state and BLM.

Table 4.7-E. Past, Present, and Reasonably Foreseeable Oil and Gas Development on the North Slope

Unit/Area	Field/Satellite	Year Discovered	Year Began	Oil and Condensate			Natural Gas			Natural Gas Liquids	
				2005 (bbl)[1]	Cumulative (bbl)[2]	Reserves/ Resources (MMbbl)[3]	2005 (Mcf)	Cumulative (Mcf)	Reserve (Bcf)[3]	2005	Cumulative
Past Production and Development											
Duck Island	Endicott	1973	1987	6,398,000	438,716,615	117[4]	139,143,000	2,084,748,702	843	979,000	22,127,757
	Sag Delta North	1989	1989	--	--	--	--	--	--	--	--
	Eider	1998	1998	32,000	2,753,804	--	1,160,000	26,485,486	--	--	--
	Ivishak	--	--	43,000	8,053,673		32,000	6,585,522		<1,000	112,016
Prudhoe Bay	Prudhoe Bay	1967	1977	118,552,000	10,908,568,865	2497	2,823,514,000	53,455,648,737	23,000	21,420,000	485,879,343
	Lisburne	1968	1981	3,050,000	145,984,886	43	57,695,000	1,568,531,189	1,000	320,000	14,699,489
	Niakuk	1985	1994	2,621,000	84,565,838	21	2,481,000	72,181,367	26	48,000	1,044,037
	West Beach	1976	1994	1,000	3,361,555		17,000	20,028,884		1,000	220,155
	North Prudhoe Bay	1970	1993	1,000	1,985,858		35,000	6,651,042		1,000	84,922
	Pt. McIntyre	1988	1993	11,789,000	395,596,487	205	76,822,000	757,820,250	500	844,000	9,239,498
	Pt. McIntyre und.	1988	1997		33,480			30,008			600
	Midnight Sun	1998	1999	2,132,000	15,557,443	426[5]	5,759,000	49,548,318			
	Aurora	1999	2001	3,452,000	18,663,094		8,663,000	67,705,494			
	Borealis	1999	2001	7,077,000	43,662,827		5,610,000	38,490,533			
	Orion	2001	2003	2,897,000	5,206,000		3,703,000	6,219,000			
	Polaris	1999	2001	1,248,000	5,607,929		1,280,000	4,455,000			
	Niak IV-SR				65,388			504,427			
	Raven	2004	2005			14	1,015,000	1,015,000	72		
Kuparuk River	Kuparuk	1969	1981	50,442,000	2,067,614,940	864	97,292,000	2,574,041,078	1,000		
	Tabasco	1992	1998	1,531,000	12,698,032	14	345,000	2,010,241			
	Tarn	1992	1998	8,085,000	79,673,640	47	13,366,000	116,603,495	50		
	West Sak	1969	1998	4,175,000	26,479,396	461	2,743,000	13,094,811	100		
	Meltwater	2000	2001	2,103,000	11,163,535	14	5,368,000	26,812,132			
	Palm	2001	2002			94					
Milne Point	Milne Point	1969	1985	9,508,000[6]	198,290,186[6]	391[7]	5,894,000	103,553,340	14		
	Cascade	1993	1996								

Unit/Area	Field/Satellite	Year Discovered	Year Began	Oil and Condensate			Natural Gas			Natural Gas Liquids	
				2005 (bbl)[1]	Cumulative (bbl)[2]	Reserves/ Resources (MMbbl)[3]	2005 (Mcf)	Cumulative (Mcf)	Reserve (Bcf)[3]	2005	Cumulative
	Schrader Bluff	1969	1991	6,408,000	49,219,747		5,285,000	32,141,580			
	Sag River	1968	1994	88,000	1,779,538		125,000	1,828,255			
	Ugnu		2003	2,212	1,606		242	3,370			
Badami	Badami	1990	1998	<1,000	4,979,350	2	1,120,000	28,213,106			
Colville River	Alpine	1994	2000	43,797,000	226,447,647	341	49,433,000	261,494,365	60		
	Fiord	1999	2006	1,772,912	1,772,912	50	1,128,132	1,128,132			
	Nanuq	2000	2006	26,815	26,815	40	303,318	303,318			
Northstar	Northstar	1984	2001	22,421,000	108,513,279	115	142,131,000	509,870,080	450		
Past Production and Development											
National Petroleum Reserve Alaska	East Barrow	1974	1981				80,000	8,162,000	5		
	South Barrow	1949	1950				53,000	22,538,000	4		
	Walakpa	1980	1993				1,255,000	15,168,000	25		
	Umiat	1946			40536[8]	70[9]					
Total				**395,224,945**	**16,652,061,413**	**5,807**	**3,452,850,692**	**61,883,614,262**	**27,149**	**23,613,000**	**536,753,455**
Present Development and Production											
Colville River	Alpine West (CD-5)										
	Lookout (CD-6)										
	Spark (CD-7)										
Reasonably Foreseeable Oil and Gas Development											
Western Group	Kalubik	1992	Offshore								
	Thetis Island	1993	Offshore			250					
	Oooguruk	2003	Offshore								
	Nikaitchuq[10]	2004	Offshore								
Central Group	Gwydr Bay	1969	Offshore			320					
	Pete's Wicked	1997	Onshore								
	Sandpiper	1986	Offshore								
Eastern Group	Point Thomson	1977	Offshore								
	Liberty	1983	Offshore								
	Mikkelson	1978	Onshore								

Unit/Area	Field/Satellite	Year Discovered	Year Began	Oil and Condensate			Natural Gas			Natural Gas Liquids	
				2005 (bbl)[1]	Cumulative (bbl)[2]	Reserves/ Resources (MMbbl)[3]	2005 (Mcf)	Cumulative (Mcf)	Reserve (Bcf)[3]	2005	Cumulative
	Sourdough	1994	Onshore			1,000					
	Yukon Gold	1994	Onshore								
	Flaxman Island	1975	Offshore								
	Stinson	1990	Offshore								
	Hammerhead	1985	Offshore								
	Kuvlum	1987	Offshore								
Undiscovered			Onshore			11,150					

1 Annual production of oil in barrels (bbl) in 2005 (ADNR 2006).
2 Cumulative oil production in barrels (bbl) and natural gas in thousand cubic feet (Mcf) since discovery through 2005 (ADNR 2006).
3 Past Production and Development: Remaining reserves of oil in million barrels (MMbbl) and of natural gas in billion cubic feet (Bcf) as of December 2005 per ADNR Division of Oil and Gas (ADNR 2006), except where noted. Present Development and Production: Undeveloped reserves (MMbbls) from Alpine Satellite Development FEIS (USDOI BLM 2004c). Reasonably Foreseeable Oil and Gas Development: Resource estimates (1,570 MMbbls) for Western-Central-Eastern categories from Northwest IAP/EIS (USDOI BLM and MMS 2003). Resource estimates for the Undiscovered Onshore category includes 4,050 MMbbls from Northeast National Petroleum Reserve - Alaska (Alternative C; for Alternatives A, B, and D this figure would be reduced to 2,900 MMbbls, 3.350 MMbbls, and 3,700 MMbbls, respectively), 3,580 MMbbls from the Northwest National Petroleum Reserve – Alaska Preferred Alternative, and 3,520 million bbls from unnamed fields in the central arctic area east of NPR-A.
4 Endicott reserves include those in Endicott, Sag Delta North, Eider, and Ivishak.
5 Includes reserves for the Prudhoe Bay satellites Midnight Sun, Aurora, Borealis, Orion, and Polaris.
6 Milne Point includes Cascade annual and cumulative production.
7 Combined Milne Point Unit.
8 Total of oil produced on formation tests from Umiat test wells 1946-1952 (Collins 1958).
9 Kumar, et al. (2002).
10 Unit application approved April 29, 2004 (ADNR 2004c).

Table 4.7-F. North Slope Oil Infrastructure (1968-2001)

	1968	1973	1977	1983	1988	1994	2001
Gravel Roads							
Oil field (miles)	0	100	139	294	358	370	400
Oil field (acres)	0	677	1,002	2,029	2,448	2,536	2,745
Dalton Highway (miles)[1]	0	170	170	170	170	170	170
Dalton Highway (acres)[1]	0	332	332	332	332	332	332
Gravel Pads							
Production, processing, support, exploration (facilities)	4	100	158	277	325	341	353
Production, processing, support, exploration (acres)	14	901	1,981	4,570	5,552	5,692	5,811
Airstrips	1	15	19	20	20	20	20
Airstrips (acres)	6	136	252	287	313	313	287
Offshore islands	0	0	2	12	15	16	17
Offshore islands (acres)	0	0	5	54	133	149	155
Gravel Mines							
In rivers (acres)	25	4,732	4,996	5,011	5,063	5,061	5,082
In tundra (acres)	0	34	151	745	1,179	1,186	1,283
Pipeline Corridors (miles)							
Oil field[2]	NA	NA	NA	NA	NA	NA	450
Trans-Alaska Pipeline[3]	0	166	166	166	166	166	166
Tundra Impacted Areas (acres)							
Gravel footprint areas[4]	20	1,714	3,240	6,940	8,446	8,690	8,998
Other impacted areas[5]	308	1,388	1,552	1,694	1,698	1,762	1,765
Gravel mines	25	4,766	5,146	5,756	6,241	6,247	6,364
Total Disturbed Area (acres)	353	7,868	9,938	14,390	16,385	16,689	17,127

[1] Does not include portions of the highway south of the North Slope.
[2] Multiple pipelines are included in some corridors, e.g., 366 miles have 1-5 pipelines and 73 miles have 6-11 pipelines.
[3] A buried gas pipeline (10 inches in diameter for 34 miles and 8 inches for 110 miles) roughly parallels the oil pipeline south to Pump Station No. 4; mileage only includes those on the North Slope.
[4] Includes gravel roads, gravel or paved airstrips, and offshore and onshore gravel pads/islands. Excludes causeways.
[5] Includes exploration site-disturbed area around gravel pad, exploration airstrip, peat roads, tractor trail, exploration roads, and gravel pad removed.
NA – Not available.
Source: NRC (2003).

Cleanup and Rehabilitation Activities on the North Slope

Concurrent with exploration in the 1970s was a greater awareness of the need to protect the Arctic environment from exploration activities and to clean up debris left from earlier exploration activities. Equipment and supplies that were previously hauled by D-8 Cat trains, sometimes during the summer with the blade down, were now moved in winter by rolligons–large vehicles with low-pressure balloon-like tires. In 1975, the Navy began preparing an EIS for activities in the northeastern portion of PET-4; this EIS would later expand to cover the entire Reserve and was completed in spring 1977. As part of the Final EIS, the Navy, in cooperation with the USGS, drew up stipulations concerning winter road and trail construction.

In 1976, drilling fluids from a site near Teshekpuk Lake broke through a retaining berm and flowed into Teshekpuk Lake. Although the amount of damage to the environment was minimal, all future reserve pits were designed to contain the total estimated volume of drill cuttings and muds below the level of the original tundra surface.

In 1976, a cleanup program was initiated, based out of Point Lonely and Barrow. During the summer of 1976, over 23,500 drums were retrieved and 750,000 pounds of debris collected. In 1977, another 26,500 drums and 485 tons of debris were collected. In 1978, over 2 million pounds of debris were collected, primarily from the Skill Cliff Air Force Tower site and the Navy's Topagoruk and East Topagoruk test well sites. In 1979, another 1.8 million tons of debris were collected at old Navy sites and other sites in the NPR-A.

Rehabilitation of pads and other disturbed sites began in the late 1970s, with the focus on lowering the drill pads and obliterating their straight edges, filling reserve pits, and revegetating sites. Germination success varied depending upon growing conditions during the summer; wet and foggy summers usually resulted in poor germination. It is estimated that about 550 acres were disturbed during the 1975-1982 USGS exploration program, that revegetation was attempted on 440 acres, and that vegetation became well established on nearly 400 acres by 1982.

In 2004, continued erosion of the northern coastline threatened J.W. Dalton Test Well #1. Approximately 600 feet of coastline eroded into the Beaufort Sea over the previous two years. Mobilization of well plugging equipment, excavation of the reserve pit soil and plugging of the well took place over the following winter. The reserve pit had been sampled prior to the onset of winter and it was determined that a portion of the pit required excavation due to environmental concerns. The soil was brought to Lonely (3 miles west), bagged into Supersacks, then transported by barge for proper disposal during late summer 2006.

4.7.3.2 Present Development and Production on the North Slope and in the Planning Area (2007-2010)

Present Development and Production (within the next few years) includes fields that are in the final planning stages for development or are under construction but have not yet begun production (Table 4.7-E). Infrastructure components, scheduling, and reserve estimates are fairly well defined, although reserve volumes are likely to be revised as information is obtained during production operations. Because many new developments on the periphery of existing infrastructure would be tied to these facilities, continued operation of current production facilities and transportation systems is vital to new development projects.

The Alpine Satellite Development Plan would develop five new fields (CD-3 through CD-7) and tie these remote pads to the existing Alpine oil field infrastructure (USDOI BLM 2004c). In 2003, ADNR estimated the CD-3 through CD7 pads, corresponding with former exploratory well locations, could produce a total of 330 MMbbl of oil in the next 2 decades (ADNR 2003). Two of these satellite fields (CD-3 and CD-4) are now producing oil. The remaining fields in this project are in the permitting stage. In August 2004, ConocoPhillips announced a proposed expansion of the CD-2 field, with original oil in place in the expansion area estimated at 31 to 55 MMbbl (Petroleum News Alaska 2004a). In August 2006, ConocoPhillips applied for a pad expansion to allow room for an additional 18 wells at CD-2 (Petroleum News, 2006c). The expansion will permit development of the Qannik oil reservoir and provide additional storage areas for the Alpine CD projects. Plans for CD-5 are in the permitting stage, however, there are some unresolved issues with development due to outstanding permits and an increasing project cost.

(Petroleum News. The Explorers 2006 – Conoco's exploration plans shaping up. Kay Cashman. Vol 11, No.46. Nov 12, 2006) It is projected to be online by 2009. ConocoPhillips has considered drilling the CD-5 wells from the CD-2 pad, however, there are no drill rigs on the North Slope capable of accomplishing that, nor is it cost effective (Petroleum News, 2006c).

Produced fluids from the production pads (CD-2, CD-3, CD-4) are transported by pipeline to the Alpine CPF (CD-1) for processing. All CD pads are connected or have proposed connections by gravel roads to existing Alpine infrastructure with the exception of CD-3, which is accessible by a gravel airstrip.Gravel used for construction of roads, pads, and airstrips would be obtained from the existing ASRC Mine Site and the Clover Potential Gravel Source. The gravel pads are or are projected to be at least 5 feet above the surrounding tundra. A 1,200-foot bridge across the Nigliq Channel near CD-2 would accommodate road traffic and the pipelines. The proposed bridge is designed to support up to 350,000 lbs per lane for heavy equipment. Proposed field CD-6 and its access road and pipelines would be within a 3-mile setback from Fish Creek, established by the 1998 Northeast IAP/EIS ROD (Lease Stipulation 39[d]). Consistent with the requirements of the 1998 Northeast IAP/EIS ROD, the Alpine Satellite Development ROD grants an exception to allow this infrastructure within the setback. Additional exceptions are granted to locate oil infrastructure within 500 feet of some water bodies (Lease Stipulation 41) and to allow roads between separate oil fields (Lease Stipulation 48). Above ground pipelines would be supported on VSMs and would be at elevations of at least 7 feet above the tundra at VSMs. Powerlines would be supported by cable trays placed on the pipeline VSMs; cable trays would not hang below the pipelines. Both industry and local residents would use the gravel roads.

Other projects likely to come into production in the next few years include additional development at two drill sites in the Kuparuk River Unit West Sak oil field, where production would increase by approximately 45,000 bbl per day in 2007 (Petroleum News Alaska 2004b).

4.7.3.3 Reasonably Foreseeable Future Development and Production

Reasonably Foreseeable Future Development and Production projects could develop discoveries that are listed in Table 4.7-E. The developments most likely to occur and those that would occur soonest generally would be near existing fields, where infrastructure systems could be shared. Below under the heading of "Northwest National Petroleum Reserve-Alaska," there is a scenario for the gravel footprint and other attributes of development of the Northwest NPR-A. BLM provides specific Northwest NPR-A scenario information for two reasons. First, the U.S. District Court for the District of Alaska found that BLM's Northeast NPR-A Amended IAP/EIS failed to fully address the cumulative impacts increased activities in the Northeast NPR-A planning area will have when combined with increased activity in the Northwest NPR-A planning area. Second, BLM has updated its projections for oil extraction from the Northwest NPR-A and the development that would be associated with such oil production from what was presented in the Northwest NPR-A IAP/EIS and used in the Northeast Amended IAP/EIS. For both of these reasons, BLM believes it is important to present a detailed and updated description of potential development in the Northwest planning area.

Development scenarios for the Northeast NPR-A IAP/EIS for Alternatives A through D are presented in **section 4.2.1.2**. To assist in estimating impacts from other North Slope oil and gas development, BLM is assuming that the growth of the future gravel footprint outside of Northeast NPR-A and Northwest NPR-A due to oil and gas development would continue at a rate exhibited in recent years related to onshore development in the area east of NPR-A. Prior to 1988, during which the main North Slope road system and most of the pads for the Prudhoe

Bay and Kuparuk oil fields were built, the average annual gravel footprint growth was 421 acres. Between 1988 and 2001, the average growth rate was 42 acres per year. (Table 4.7-F) For analysis purposes, BLM in this Supplemental IAP/EIS is assuming that the total growth in the oil and gas gravel footprint on the North Slope through this century could be the sum of 1) the footprint attributed to development in Northeast NPR-A described for each alternative in **section 4.2.1.2,** 2) the footprint attributed to development in the Northwest NPR-A described below, and 3) 42 acres per year attributable to all other North Slope oil and gas development.

Projecting the growth of the gravel footprint far into the future is very problematic. BLM's projections for the growth of the gravel footprint in Northeast and Northwest NPR-A exceed the recent growth rate on the North Slope. Each of these two BLM planning areas would average about 60 acres of new gravel footprint per year from about 2020 to some point in the later half of this century according to the scenarios presented in this Supplemental IAP/EIS. This is due to a variety of factors, including a possible over-estimate of oil production from these areas (and thus of development) and development scenarios for these planning areas that are designed to not underestimate the acreage attributed to future development. Also, the larger average footprint growth in these two NPR-A planning areas is consistent with what may be expected as development occurs farther from existing infrastructure. As development moves into previously undeveloped area, there will be a need to duplicate some of the infrastructure, such as airstrips and storage areas on CPFs, that exist at Prudhoe Bay and Kuparuk and which are shared by development closer to those major fields. Thus, to some extent, in beginning to develop oil and gas in the previously undeveloped NPR-A, growth in the gravel footprint may reflect the larger initial rate of footprint expansion that occurred in the early years of development of the Prudhoe Bay and Kuparuk oil fields.

There is also great uncertainty regarding what future development may occur outside Northeast and Northwest NPR-A that could affect the amount of additional gravel footprint and what amount of the gravel footprint will be abandoned and undergo restoration. A question could legitimately be raised whether annual growth of the gravel footprint in the area east of NPR-A from 1988 to 2003 would still need to be that large in that area nearly a century from now. However, gas development on the North Slope could require gravel footprint increases that may be larger than reflected in recent gravel footprint increases related to oil development in the established oil fields in the Prudhoe Bay and Kuparuk area. Because of these potentially offsetting influences on development and other rationale described above, BLM is, for analysis purposes, assuming 42 acres of new gravel footprint annually through the end of the century on lands outside the Northeast and Northwest NPR-A planning areas. Thus, by approximately the end of this century the additional gravel footprint would be approximately:

1. Northeast NPR-A (Alternative C): 3,850 acres
2. Northwest NPR-A: 3,500 acres
3. Rest of North Slope: 3,850 acres.

Total: 11,200 acres

Assuming a ratio of one acre of gravel pit for every five acres of gravel footprint, this assumption would indicate that approximately 2,200 acres of additional gravel pits will be required.

Northwest National Petroleum Reserve – Alaska

The Northwest NPR-A IAP/EIS evaluated the potential for oil and gas development in the Northwest NPR-A (USDOI BLM MMSA 2003). The January 2004 ROD made all BLM lands within the Northwest NPR-A available to oil and gas leasing, though leasing of 1,570,000 acres in the Wainwright area were deferred for 10 years and 440,000 acres in the Colville River Special Area within the Northwest planning area were deferred until a Colville River Management is completed. This left approximately 77% of the Northwest NPR-A immediately available for leasing.

The Northwest NPR-A has a much lower economic potential on a per-acre basis than the Northeast Planning Area. The Northwest NPR-A is nearly twice as large as the planning area, but has only an estimated 46% (4,100 MMbbls) of the combined total undiscovered, conventionally recoverable oil resources (using the mean value) found in the NPR-A. Under the provisions of the Northwest NPR-A ROD all lands could ultimately be made available for oil and gas leasing, but an estimated 20 MMbbls would not be accessible because of surface occupancy restrictions. As in this Supplemental IAP/EIS's analysis of the amount of oil that might be produced from the Northeast NPR-A (See discussion in **section 4.2.1.2**), this document assumes that approximately 88% of the risked mean technically recoverable undiscovered oil estimated to be in the planning area that is available for leasing and accessible to drilling would be produced. To develop the projected amount of accessible oil within Northwest NPR-A, BLM anticipates the following amount of development:

94 exploratory wells	30 ice runways	1,400 2-D camp train miles (5,100 acres)
71 delineation wells	6,800 miles ice roads (20,600 acres)	14,500 2-D surveying acres
6 CPFs (540 acres)		625 3-D camp train miles (2,300 acres)
30 satellite production pads (300 acres)	300 miles gathering line	165,000 3-D surveying acres
3 staging bases (150 acres)	295 miles of sales pipeline	83 MMbbls peak oil production/year
6 gravel runways (66 acres)	6 pump stations (120 acres)	
300 miles gravel roads (2,325 acres)	13 gravel pits (650 acres)	

Under very favorable conditions for oil development in the Northwest NPR-A, including very high oil prices or discovery in the Northwest NPR-A of an oil accumulation that is so large that its development does not depend on infrastructure in the Northeast NPR-A, there will not be any difference in the amount of oil developed from the Northwest NPR-A no matter which of the alternatives considered in this document for the Northeast NPR-A is adopted. Under other circumstances, including lower oil prices, there could be marginal differences in the amount of, or at least the timing of, oil produced from Northwest NPR-A and, by extension, the impacts to the environment from that development. Alternatives B, C, and D all are projected to result in more oil production and development in Northeast NPR-A than under Alternative A. If these heightened production levels result in stretching infrastructure closer to Northwest NPR-A, then development of oil in Northwest NPR-A could be more cost efficient and either come into existence sooner than under Alternative A or occur under Alternatives B, C, or D while it would not under Alternative A. (Among the action alternatives, Alternative C would be the most likely to enhance the chance or speed production in Northwest NPR-A and Alternative B the

least likely, but the differences in likelihood among the action alternatives are marginal.) Similarly, by making it possible to construct a pipeline north of Teshekpuk Lake, the action alternatives under lower oil prices could make production in northeastern Northwest NPR-A more economically feasible.

Differences in the chance of development in the Northwest NPR-A among the alternatives considered in this Supplemental IAP/EIS are more likely to be reflected in the northeast corner of Northwest NPR-A than in any other portion of the Northwest NPR-A Planning area. To illustrate, consider the following. If a very large accumulation of oil in the neighborhood of 750MMbbls were discovered in the northeast corner of Northwest NPR-A, it might prove economically attractive to develop whether the investment strategies of the oil industry were based on oil prices that were higher or lower than they are today, regardless of which Northeast NPR-A alternative is chosen, or whether development occurs in Northeast NPR-A or not. If, however, the northeastern part of Northwest NPR-A is found instead to have a much smaller accumulation, such as 50MMbbls, but a very large accumulation exists in an area that is not available for leasing under Alternative A in northwestern Northeast NPR-A, but would be available under the other alternatives, the outcome could be different among the alternatives. Under A, the large accumulation would not be discovered. Unless there was other development that would be economic and bring infrastructure near the small accumulation in northeastern Northwest NPR-A, that small accumulation would be unlikely to be developed, especially under lower oil prices. In contrast, under the other alternatives, the large accumulation of oil in northwestern Northeast NPR-A could be discovered and developed. With this large accumulation justifying bringing infrastructure nearby, the smaller accumulation in the Northwest NPR-A would be more likely to be developed.

Development in the Chukchi Sea that would require a pipeline across Northwest NPR-A (see discussion below, **Chukchi Sea Planning Area**), could help support development within Northwest NPR-A, as development in Northwest NPR-A could help the economics of a development in the Chukchi Sea. BLM, however, does not believe that the infrastructure in Northwest NPR-A that would occur to support development in both areas would exceed the combined development described for each area separately. Indeed, it is quite conceivable that the infrastructure to develop the two areas would be less than additive, since some infrastructure, such as pipelines, could be shared.

Chukchi Sea Planning Area

The MMS has produced a hypothetical development scenario as part of the Chukchi Lease Sale 193 Draft EIS. The scenario assumes an abrupt increase in the level of activity compared to the past. The Chukchi is viewed as one of the most petroleum-rich offshore provinces in the country with a mean conventional recoverable oil resource of 12 Bbbl. The actual size and location of future oil and gas developments in the Chukchi are uncertain. However, for purposes of analysis, the MMS estimated that one oil field containing 1 billion barrels (Bbbl) would be developed as a result of Sale 193. The scenario for new petroleum development in the Chukchi took into account existing infrastructure on the North Slope because it is likely that future projects in northern Alaska will be tied into these facilities. Under this scenario, production from the Chukchi lease sale area could begin in 2020 with peak oil production rate from the first offshore field assumed to be approximately 225,000 bbl per day. This would constitute a 25% increase to the current rate through TAPS, which is assumed to carry oil production from the Chukchi. The MMS believes this increase would require upgrading the pipeline and pump stations because many of the pump stations have been idle due to declined volumes flowing through TAPS.

Approximately, 100,000 line miles of 2-D seismic data has been collected to date. Exploration will continue including 3-D seismic surveys to define prospective drill locations. These surveys will take place during the open water season (May-September). Typical 3-D survey operations will consist of a large seismic vessel that tows the airgun and receiving cable arrays and a smaller support boat. Survey times will average 20 to 30 days (with downtime) to cover a 200 sq-mi area. Under normal vessel speeds, the airgun array would produce a sound signal every 20-30 seconds. The 3-D surveys could commence prior to lease sale 193. Up to 4 surveys could take place during each open water season. During exploration seismic surveys, the vessels are largely self-contained, so there would be a minimum amount of helicopter flights (assume one per day) to transport personnel, seismic data, and light supplies.

Data from seismic will be used to drill and delineate a commercial field. The scenario projects an additional 7 to 14 wells before development will occur. A large, bottom-founded platform would be constructed to withstand the water depths and constant ice movement. The platform would hold 1-2 rigs and serve as a central processing facility. Subsea wells would be completed in templates of 4 wells with flowlines connecting the wells with the central processing platform. An 18" oil pipeline would be trenched in the seafloor between the platform and landfall (30-150 miles). This work would take place during the ice-free months. At the landfall location, a pump station would be constructed, possibly between Icy Cape and Point Belcher. Additional pump stations may be required along the corridor and would be co-located with oil fields along the corridor. The exact route of the overland pipeline is unknown, but will likely be routed south of Lake Teshekpuk and avoid sensitive areas where possible.

There is no infrastructure in NPR-A at the present time, so a new large-diameter gathering line would have to be constructed from the Chukchi coast to the Prudhoe Bay area. The pipeline and communication lines would be constructed on elevated vertical supports during the winter to connect with the western extent of the TAPS pipeline infrastructure (no greater than 300 miles). Pump stations would be needed at about 100-mi intervals and where possible would be co-located with oil field facilities along the corridor. The size and location of the overland pipeline(s) will be influenced by future discoveries and development in the NPR-A, but it is logical to assume that they would be oriented west-east in the shortest corridor to Pump Station No. 1. Separation of associated-dissolved gas and produced water from the offshore field would be done on a central production platform in the Chukchi Sea. Natural gas would not be transported across NPR-A until a transportation system is constructed from the North Slope to Outside markets. Development in the Chukchi Sea that would require a pipeline across much of NPR-A could help support development in northern NPR-A, as development in NPR-A could help the economics of a development in the Chukchi Sea. BLM, however, does not believe that the infrastructure in northern NPR-A that would occur to support development in Northeast NPR-A, Northwest NPR-A, and the Chukchi Sea would exceed the combined development described for each area separately. Indeed, it is quite conceivable that the infrastructure to develop the three areas would be less than additive, since some infrastructure, such as pipelines, could be shared.

Leasing to production would take approximately 15 years. The total life-cycle of the offshore project could last 30-40 years with 25 years of oil production. Upon abandonment, offshore pipelines would be decommissioned by cleaning, plugging both ends and leaving it in place buried in the seabed. The overland pipe is likely to be in use by other oil fields in NPR-A, so it would remain in operation. If it was not used or there was no plan to use it then it would be decommissioned and abandoned with removal and rehabilitation similar to that described in **section 4.7.4.4**. The offshore platform would be disassembled and removed and the seafloor will

be restored to a pre-development condition. The abandonment process could take several years with environmental studies continuing beyond that.

The MMS's Draft EIS also describes anticipated transportation in support of exploration and development in the Chukchi. During exploration drilling, operations would be supported by both helicopters and supply vessels. Helicopters would probably fly from Barrow at a frequency of 1-3 flights per day. Support vessel traffic would be 1-3 trips per week, also out of Barrow.

Construction of a new shorebase would begin after a commercial discovery is made. Heavy equipment and materials would be moved to the coastal site using barges, aircraft, and perhaps winter ice roads. Transportation activities would be more frequent during the construction phase, beginning about 3 years after the discovery is made and will take another 3 years for completion of the new facility. During this construction phase, there could be 1-2 barge trips (probably from either West Dock or Nome) in the summer open water season. Aircraft (C-130 Hercules or larger) trips could be up to 5 per day during peak periods. The overall level of transportation in and out of the shorebase would drop significantly after construction is completed for both the shore base and offshore platform. During production operations aircraft would generally be smaller with less frequent flights (2 per day). Ice road traffic would be intermittent during the winter months.

If drilling, cutting, and spent mud from subsea wells to be disposed at an onshore disposal facility, it is estimated one barge trip per subsea template (4 wells). This means that there could be 2 barge trips (during summer) to the new onshore facility over a period of 6 years.

Onshore Between NPR-A and the Arctic National Wildlife Refuge

Additional amounts of oil could be produced by enhanced recovery technology from existing fields and from undeveloped or undiscovered satellite pools adjacent to existing production areas east of NPR-A. Some of this production would replace declining production at existing fields. It is reasonable to assume that a portion would be brought into production in the foreseeable future. Consistent with this Supplemental IAP/EIS's treatment of undiscovered oil within NPR-A, this analysis assumes for analysis purposes that approximately 88% of the estimated undiscovered oil in the area would be brought into production in the foreseeable future.

Enhanced recovery and some satellite fields would be developed largely from existing infrastructure, including existing pads, roads, and pipelines, and much of the oil would be processed in existing processing facilities. Oil that cannot be reached with extended reach drilling from existing pads would require construction of new pads. Oil accumulations near existing infrastructure may be developed with a gravel road connecting to the existing infrastructure and utilize much of the existing oil processing facilities, worker facilities, maintenance equipment, and storage, as was done in the recently constructed Meltwater and Drill Site 3S production pads. Accumulations farther from existing infrastructure might be developed similar to the Alpine and Badami fields, which are not linked to the infrastructure at Prudhoe Bay by road and have their own oil processing, personnel, maintenance, and equipment storage facilities. Access would most likely be provided by a mix of ice roads, air, and, if on the coast, barge.

Beaufort Sea

Geophysical exploration has occurred in the Beaufort Sea for decades with practices similar to those described above for the Chukchi Sea. These practices, which are anticipated to be continued in the Beaufort, include use of seismic vessels, ice breakers, support vessels, and aircraft or helicopters. Geophysical operations would be conducted between April and October during open water.

Depending on water depth, exploration wells in the Federal and state waters in the Beaufort Sea would either be drilled from man-made ice islands or large, heavy, bottom-anchored, ice-resistant drilling rigs. Artificial ice islands may be employed as drilling platforms in less than about 10 to 15 m of water, and their construction and supply would be supported by ice-roads. In deeper water, bottom-founded structures would likely be employed to support drilling operations. Gravel islands, constructed in winter, could be employed for exploratory and delineation drilling activities in nearshore waters. Gravel would come from an onshore location and be transported to the site via ice road.

If a discovery is made and the field developed, a permanent facility would be built on an existing island or manmade gravel island, such as that constructed for the Northstar development, which began production in 2001. The platform would include several production wells, water injectors, gas injection wells, and a waste disposal well. Some of the natural gas produced would be used to power equipment on the facility, but most would be re-injected to maintain reservoir pressure. Produced water would also be reinjected (ADNR 2000). The offshore production pad would be accessed by helicopter, barge, and, periodically, ice road. A subsea pipeline would bring the oil to land, where it would be processed, either in existing facilities or, if too distant from existing facilities, new processing facilities. Only if the field was a great distance from shore, as is the scenario contemplated by MMS in the Chukchi Sea, is it likely that processing would occur offshore. Once processed, the oil would pass through existing or new pipelines, with new pump stations, if necessary, to TAPS.

At high oil prices, it would not make a difference which alternative is adopted in the Supplemental IAP/EIS. However, alternatives B, C, and D all make development of a pipeline and other infrastructure north and east of Teshekpuk Lake more feasible. Consequently, at lower oil prices or in the case of smaller oil accumulation in the offshore north and east of the Teshekpuk Lake area, development would be accelerated or become more likely under these action alternatives.

Gas Pipeline and North Slope Gas Development

Development of North Slope gas is a long-time dream of many Alaskans. As long ago as 1977 the Federal Energy Regulatory Commission completed an environmental impact statement for the Alaska Natural Gas Transportation System (ANGTS) and three years later issued a 30-year lease for the project that would have brought North Slope gas south to Delta Junction and then to Alberta parallel the Alaska Highway. Other projects have been proposed. Most notable among these was the Trans-Alaska Gas System (TAGS), for which an EIS was completed in 1988 and a 30-year lease issued by BLM in 1995. It would have brought gas to Valdez where it would be converted to liquefied natural gas for shipment (FERC, 2006). But no development has occurred.

North Slope oil wells also produce natural gas and water but, without a gas pipeline to market, industry re-injects the gas that is not used for field operations back into the oil producing

reservoir to improve oil recovery (but where it also remains available for commercial production). There is, however, a possibility that substantial steps will be taken to bring about a gas pipeline before this Supplemental IAP/EIS is completed or shortly thereafter. Concurrent with the drafting of this Supplemental IAP/EIS, the Governor of Alaska is undertaking a process designed to identify a prospective pipeline licensee to build a gas pipeline. Governor Sarah Palin's plan has taken the form of a bill—the Alaska Gas Inducement Act—introduced in the 2007 legislative session. Under Governor Palin's plan, the state will put out requests for applications to prospective licensees at approximately the same time as this Draft Supplemental IAP/EIS is available for public review. At about the time that the Final Supplemental IAP/EIS is set for publication, the governor intends to announce her choice of the licensee. And at about the time that a lease sale could be offered in Northeast NPR-A under a new ROD based on the Supplemental IAP/EIS, the licensee is anticipated to undertake investigative fieldwork. Submission of applications for Federal and state permits and actual construction may commence within the following few years (Anchorage Daily News, 2007). As a consequence, BLM is considering commercial gas pipeline and North Slope gas development outside of the planning area as reasonably foreseeable and including analysis of their impacts within the cumulative impact analysis.

Because there is no proposal before any agency for a gas pipeline and there is neither a commercial gas development on the North Slope to serve as an example of such a development, nor a proposal for one, the descriptions of these facilities and their impacts are necessarily less specific in some aspects than are the scenarios for oil development. Nevertheless, the descriptions provided in this section are based upon several recent projections of a future gas pipeline and associated North Slope developments and provide the reader with a detailed understanding of the potential impacts a gas pipeline and North Slope gas development would entail.

The following description of a gas pipeline from the North Slope to markets is derived primarily from the Alaska Natural Gas Transportation System R/W Lease: Commissioner's Analysis and Proposed Decision and Action (ADNR, 2004d). This State of Alaska Department of Natural Resources document describes one proponent's plan for a pipeline. It is the most thorough recent description of such a gas pipeline. It may differ in some respects from plans of other proponents of a gas pipeline—for instance, it contemplates a 48-inch pipeline while the North Slope leaseholders indicate that they are contemplating constructing a 52-inch pipeline. In general terms, however, it represents a realistic scenario for a gas pipeline from the North Slope, particularly for its route and characteristics in the northern part of the state where a gas pipeline may most reasonably be expected to contribute to any cumulative impacts on resources and uses in the Northeast NPR-A.

A commercial gas pipeline would have its origins at Prudhoe Bay. Gas would first be processed in an as-yet-to-built gas conditioning plant. From there a pipeline would follow the TAPS and the Dalton Highway in a southerly direction from Prudhoe Bay, probably passing from the North Slope through the Brooks Range at Atguin Pass. The buried pipeline would meet the requirements of the Code of Federal Regulations (CFR) Title 49, Part 192 and API-5L, Grade X80. It would be approximately 50 inches in diameter with approximately 1-inch-thick walls. Its annual average daily capacity would range from 4,500 to 5,900 million standard cubic feet per day. The maximum allowable operating pressure is anticipated to be 2,500 pounds per square inch. One metering station would occupy about 5 acres at Prudhoe Bay. One, and possibly more, compressor stations of 25- to 35-acres (fenced gravel pads) would be located on the North Slope, with five or more additional compressor stations placed further south on the gas pipeline route. The ANGTS plan states that its compression equipment would consist of "a

44,000 HP (ISO) Dry Low Emission (DLE) gas turbine powered single stage centrifugal compressor with dry gas seals." The compressor package would be equipped with "low noise' compressor intake and exhaust, and a sound reducing unit enclosure and compressor building." ANGTS proponents anticipate that the gas pipeline would be placed adjacent to the Dalton Highway along most of its route in the North Slope, passing under the road more than a half dozen times before leaving the region.

The pipe would be externally and internally coated and a combination of external coating and a cathodic protection system would provide corrosion control. Mainline block valve assemblies would be provided at a nominal spacing of 20 miles and at compressor station locations. Launchers and receivers for pipeline in-line inspection devices (pigs) would be installed at compressor and metering stations. The ANGST pipeline system would be controlled remotely using a Supervisory Control and Data Acquisition (SCADA) system, based out of a central gas control center possibly located in Calgary, Alberta. The ANGST compressor stations and pipeline operating conditions would also be monitored from an operations and maintenance station that might be located near Fairbanks. In addition, compressor stations and mainline block valves would have local control systems, which could shut down the compressor station or close a mainline block valve automatically in the event of an emergency.

Prior to the start of construction, the builder would finalize surveys, locate the centerline and construction workspace, and complete land or easement acquisition. The right-of-way would be surveyed and staked, and existing utility lines would be located and marked to help prevent accidental damage during pipeline construction. Construction support activities, which would include double jointing pipe, stockpiling pipe, clearing, aggregate processing, camp mobilization, and some access road construction, would commence a year prior to mainline construction activities. Existing roads would provide access to the pipeline route, though some temporary access roads may be required and, if not already available, some permanent, high-grade access roads would be needed to provide access for compressor station sites. Clearing of the pipeline right-of-way would generally be completed the winter prior to mainline construction activities. Vegetation would be removed by mechanical cutting.

During construction, camps would be utilized for crews and construction supplies and equipment. Camps may house 250 to 1,700 workers, depending on location and the work to be accomplished. Old TAPS construction camp sites, such as Franklin Bluffs, Happy Valley, Toolik, Galbraith, Atigun, and camps farther south would likely be reestablished.

North Slope and most other Alaskan construction of the gas pipeline would occur in winter when snow and ice would provide the work surface. Chain trenchers would be used for ditching through permafrost areas and where geotechnical conditions permit. The use of chain trenchers eliminates the need to drill and blast in most permafrost and reduces the amount of imported backfill. Hard rock, however, would be drilled and blasted, then the broken rock removed by backhoes. In non-permafrost areas, conventional ditching methods would be used, which would include the use of backhoes and wheel trenchers. The trench would be dewatered, cleaned of debris, and padded as necessary before the pipe would be lowered into the trench. If the excavated material is rocky, the pipe would be padded with select fill from material sites or by separating suitable material from the existing trench spoil.

Cleanup and restoration of the construction areas would begin after backfilling and it would likely be the intent that all cleanup and restoration (except reseeding) be accomplished in the same winter season as trenching and laying of the pipeline. After backfilling, the work areas would be graded and restored to approximate pre-construction contours. Surplus construction

material and debris would be removed and recycled. Permanent erosion controls (water bars or slope breakers) would be installed as conditions warrant. Construction work areas would be seeded the following summer when conditions would be suitable.

Access to the pipeline for routine inspection and maintenance would to a very large extent involve travel on existing access roads. This could be the case along the majority of the route on the North Slope where the gas line would be placed in very close proximity to the Dalton Highway. Where the pipeline is not adjacent to an existing road, ice or snow roads may be constructed for winter access to perform routine work. In the event of an emergency situation where equipment would need to access an off-road area, proponents of the ANGTS plan that "temporary work pads and roads would be utilized and specialized techniques would be used to reduce potential impacts." Access to any permanent gravel access road to gas pipeline infrastructure would be restricted to prevent unauthorized access and potential environmental damage caused by vehicle travel. The right-of-way would be monitored, and erosion or unstable conditions would be repaired in accordance with any permits issued by the various authorizing agencies.

Presuming a gas pipeline is completed, commercial gas development could occur onshore in or near existing fields between NPR-A and ANWR and in parts of NPR-A outside the current planning area, and offshore in the Beaufort and Chukchi Seas. Much of the initial gas that might be produced on the North Slope and nearby offshore areas would come from existing oil fields and would rely as much as practicable on the existing roads, pads, and other infrastructure. But the presence of a commercial gas pipeline would also spur additional development that could contribute both oil and gas production. Where gas accumulations occur near existing infrastructure (but not close enough to be efficiently tapped by drilling from existing pads), they may be developed with new gravel pads and gravel roads connecting to the existing infrastructure. In such a case, they could utilize existing oil, or new centralized gas, processing facilities, worker facilities, maintenance equipment, and storage facilities. Gas accumulations farther from some then-already-existing infrastructure might be developed as stand-alone facilities, with their own processing, personnel, maintenance, and equipment storage facilities. Access would most likely be provided to these stand-alone developments by a mix of ice roads, air, and, if on the coast, barge.

North Slope gas development would in time cause geographic expansion of onshore oil and gas infrastructure. Completion of a commercial pipeline from the North Slope would likely prompt development of Point Thomson far to the east of existing infrastructure. Industry has also exhibited interest in gas prospects south of existing oil infrastructure in the foothills of the Brooks Range. As described in the Northwest NPR-A IAP/EIS, gas could be developed from new infrastructure (much of it also associated with new oil production) in both the northern and southern parts of that planning area in NPR-A. The as-yet-unplanned portions of the remainder of NPR-A outside of Northeast and Northwest NPR-A, is thought to have more than a quarter of the gas endowment of the Petroleum Reserve and, if made available following NEPA review, would also be a possible area for gas development.

While there is good reason to believe that some of the earliest gas to be delivered through a commercial gas pipeline would originate from gas deposits readily accessible from existing infrastructure, timing of gas production from specific existing infrastructure and known gas accumulations, and the development of new infrastructure to reach more distant gas accumulations will involve complex technical, economic, and corporate considerations. Although it may be assumed that as a rule, gas accumulations closer to existing infrastructure, using existing infrastructure, would be produced sooner than other accumulations, and that gas

accumulations farthest from existing infrastructure would be produced last, this may not always be the case.

Development of gas from the Chukchi Sea, areas of NPR-A west of the planning area, and areas of the Beaufort Sea north of NPR-A would all have particular relevance for cumulative impacts associated with the Northeast NPR-A. First, the future management decision for the planning area may have ramifications for development in adjacent areas. There may be a better chance for gas development to occur in northeastern Northwest NPR-A and areas of the Beaufort Sea directly north of Teshekpuk Lake under Alternatives B, C, or D of the Supplemental IAP/EIS than would be the case under Alternative A. The reasons for this are the same as described in Northwest NPR-A and Beaufort Sea discussion of **section 4.7.3.3** for different chances for oil development in these areas depending on which alternative is chosen for Northeast NPR-A.

Second, development in the area north and west of the planning area also could cause or facilitate development in the planning area. Offshore development north of the planning area would likely rely on some onshore facilities in the planning area. Any offshore development in the Chukchi or Beaufort seas north or west of NPR-A would almost certainly rely on a gas pipeline across the planning area, as would gas development in NPR-A west of the planning area. As well as creating direct impacts in the planning area from construction and operation of the pipeline, such a pipeline might also encourage oil and gas development within the planning area, though not in excess of what is already analyzed for each respective alternative in **sections 4.3, 4.4, 4.5, and 4.6**.

Finally, development in these lands and offshore areas could affect resources that also utilize the planning area. A few examples illustrate the point. A number of bird species and the Teshekpuk Lake and Western Arctic caribou herds use both the planning area and other parts of NPR-A. And marine mammals may be impacted both by barge traffic associated with planning area development and by gas activities that could occur offshore or indirectly by actions in support of onshore gas development in NPR-A west of the planning area.

4.7.3.4 Speculative Development

Speculative developments are those that BLM does not consider reasonably foreseeable. They may include projects that are discussed in the public arena, but which are currently prohibited by law or for which there is no current concrete proposal before an authorizing land management agency. In this analysis, approximately 12% of estimated technically recoverable undiscovered oil on the North Slope is considered speculative. Speculative developments are not considered in the cumulative impact analysis.

4.7.3.4.1 Factors Contributing to Uncertainty

There are many factors that contribute to uncertainty regarding future oil development.

Prices

The price structure and stability for oil will play a pivotal role in the future of the petroleum industry in Alaska. With low oil prices, the high cost of producing a barrel of oil in Alaska places North Slope crude oil at a disadvantage relative to the OPEC cartel and other low-cost producers. It also tends to use up funding for Alaskan projects by the producing companies who can realize a greater return on investments in lower-cost environments. When oil prices are higher the return on investment is much greater and exploration and development opportunities become more attractive to industry on the North Slope.

Land Availability
Even with sustained high oil prices, there will be no significant reserve additions without attractive exploration opportunities. These opportunities only exist when there is a continued and diverse offering of exploration acreage. A successful exploration effort requires that a broad mixture of potential play types of a size sufficient to provide economically viable targets be made available in a predictable and systematic manner. In such a scenario, exploration would provide a spectrum of field sizes such that the larger accumulations generate the demand for the infrastructure, which would in turn create an environment in which smaller fields (satellites) may be profitable to develop.

In the near future, the available relatively low-cost operating areas near existing infrastructure will have been reasonably well explored. They will be deemed to no longer have the potential to yield discoveries of sufficient size to replace the production lost due to decline of the older major fields. This realization accounts for industry interest in making new acreage available for leasing, because without new discoveries, the region's oil production will continue to decline, a decline that will eventually lead to the shutdown of operations and of the TAPS pipeline.

Reserve Estimates
When exploration begins in a new area, like in the North Slope in the 1960s, no one has direct evidence of the true nature and distribution of potential reservoirs in the subsurface, let alone the presence or volume of hydrocarbons that may be present. Seismic data used to determine the presence of potential structures and traps, and outcrop exposures, often tens or hundreds of miles away, are the sole source of possible reservoir data. Based on these bits of information, a first prediction is made as to the probability of oil or gas being present, and then if the assumptions regarding structure, trap, reservoir, and source are reasonable, what range of hydrocarbon volumes the feature could contain. The reality of potential volumes, as revealed by exploration drilling, may be different from the pre-drill predictions. Original predictions for the size of some fields have turned out to underestimate (Prudhoe Bay, Kuparuk, and Endicott) or overestimate (Lisburne as well as numerous drilled dry holes) the actual oil endowment. The development of infrastructure such as occurred at Prudhoe Bay and Kuparuk and with the TAPS, made exploration for previously unrecognized or ignored nearby small accumulations feasible. This again contributed to a larger total reserve estimate.

4.7.3.4.2 Speculative Developments

Developments listed below are considered speculative. Consequently, impacts of these developments are not considered in this Supplemental IAP/EIS.

South National Petroleum Reserve – Alaska
BLM began conducting a plan in the South NPR-A in 2005. However, after considering the results of scoping, the agency determined in May 2007 not to pursue the plan. As a consequence, development of this part of NPR-A is not considered reasonably foreseeable.

Kobuk-Seward Peninsula Draft RMP/EIS
The Kobuk-Seward Peninsula Draft Resource Management Plan (RMP)/EIS (April 2006) addressed multiple uses of 13 million acres of BLM-managed lands. The plan included a scenario for oil development only because it is BLM's policy that RMPs, when considering oil and gas leasing in frontier areas, project a minimum level of exploration and development activity for impact analysis. The RMP/EIS stated that development would be unlikely. The estimated mean technically recoverable amount of oil was about 200MMbbls and likely scattered in small accumulations. Development of such small amounts of oil approximately 350 miles from any oil infrastructure and approximately 100 miles from the area in Northwest NPR-A considered to have even moderate oil potential is considered infeasible under any foreseeable circumstance. Consequently, the oil attributed to the plays in the Kobuk-Seward Peninsula is considered speculative rather than reasonably foreseeable, and its development is not included in the cumulative analysis for this Supplemental IAP/EIS.

Arctic National Wildlife Refuge
Much of the Arctic National Wildlife Refuge on the North Slope has been designated as Wilderness. Wilderness areas are not open to oil and gas exploration and development. In addition, Section 1003 of ANILCA prohibits leasing within all of the refuge, including that part along the coastal plain commonly called the 1002 Area after the section in ANILCA that required studies and reports on the area. Section 1003 states that "no leasing or other development leading to production of oil and gas . . . shall be undertaken until authorized by an Act of Congress." Despite repeated attempts in Congress, no such legislation has been enacted and signed into law. As a consequence, development of this area is not considered reasonably foreseeable.

Road to the Dalton Highway
The State of Alaska during the administration of Governor Frank Murkowski considered construction of several roads from the existing Dalton Highway to promote development on the North Slope. A couple proposals would have connected the highway—one through a foothills route and one through the oil industry's spine road—to NPR-A via a bridge near Nuiqsut. The latter project, which entailed constructing less new roadway than the foothills route, was projected to cost $120 to $150 million (Alaska Dept. of Transportation and Public Facilities, 2004). The state on December 12, 2003 submitted an application to the Corps of Engineers for a Sec. 404 permit under the Clean Water Act for spine road project. The Corps responded on March 2, 2004 that an EIS would be necessary to consider such a permit. The state has not pursued this action further with the Corps and no Notice of Intent has been issued to consider the proposal. Consequently, the cumulative impact analysis does not consider them reasonably foreseeable.

4.7.3.5 Oil Production on the North Slope of Alaska

4.7.3.5.1 Production Through 2006

From 1977 to the end of 2006, North Slope developments produced 15.1 Bbbl of oil and natural gas liquids (Alaska Division of Oil and Gas 2006). Production on the North Slope peaked in 1988 at 2.0 MMbbl of oil per day, declining to its current rate of approximately 0.8 MMbbl per day (Petroleum News Alaska, 2007). Of the producing fields on the North Slope, the most productive (in order of productivity) are Prudhoe Bay, Kuparuk River, Alpine, and Point McIntyre.

4.7.3.5.2 Future Oil Production Estimates

Table 4.7-G provides resource estimates used in the cumulative impact analysis. These estimates include anticipated production from past, present, and reasonably foreseeable oil developments listed in Table 4.7-E.

State Lease Sales Considered in This Cumulative Effects Analysis

Since December 1959, the State of Alaska has held more than 50 oil and gas lease sales involving North Slope and Beaufort Sea leases. More than 9.8 million acres have been leased; some areas have been leased more than once because some leases expired or were relinquished. Historically, less than half of the tracts offered in state oil and gas lease sales have been leased. Of the leased tracts, about 10% have actually been drilled, and about 5% have been developed commercially (Map 3-2). About 88% of the leased areas are onshore or nearshore and about 12% are offshore. From the early 1960s through 2003, 402 exploration wells were drilled in State of Alaska onshore and offshore areas (S. McMains, AOGCC, pers. comm). During this period, the number of exploration wells drilled annually has ranged from two to 35. During the 1960s, 58 wells were drilled, 97 wells were drilled in the 1970s, and 105 wells were drilled in the 1980s. From 1990 through 2003, 142 wells were drilled and the number of exploration wells drilled annually averaged 10. Fifty-three of the exploration wells have resulted in discoveries, a success ratio of about 13%.

The State of Alaska develops and approves an oil and gas-leasing plan for a 5-year period, reassesses the plan, and publishes a schedule every year. Except for Northstar, all of the North Slope and Beaufort Sea's commercially producible crude oil is on 986 active state leases (as of December 2006) broken down as follows: 1.35 million acres onshore along the Slope; 498,000 acres offshore in the Beaufort Sea; and 456,000 acres of active leases that straddle onshore and offshore acreage. Production through 2006 from state leases totals 15.1 Bbbl. The latest state lease sales—North Slope Areawide and Beaufort Sea Areawide—were held in October 2006 (Alaska Division of Oil and Gas 2006). Between the end of 2006 and 2010, the State of Alaska is expected to hold the following annual areawide lease sales annually:

- Beaufort Sea Areawide sale including unleased state (within 3 miles of coastline) waterbottoms from Barrow to the Canadian border each October;
- North Slope Areawide sale, including unleased state lands between the Arctic National Wildlife Refuge and the NPR-A each October; and
- North Slope Foothills Areawide sale, extending into the foothills of the Brooks Range each May.

The state has not yet estimated oil and gas resources involved in these future lease sales, but informal industry estimates project 4 Bbbl in undiscovered resources on state lands on the

North Slope, which include both leased and unleased state properties. Most are expected to be producible only as satellites.

The State of Alaska is continuing efforts to drill a stratigraphic test well offshore of Arctic National Wildlife Refuge. The state also recently developed a new mitigation measure (Mitigation Measure 18) to ensure that exploration, development, and production activities are conducted in a manner that prevents unreasonable conflicts between oil and gas activities and subsistence whale hunting. The lessee has to consult with the NSB and Alaska Eskimo Whaling Commission to discuss how siting, timing, and methods of proposed operations can be planned and carried out to avoid potential conflicts with subsistence whale hunting (Petroleum News Alaska 2004c,d).

Federal Lease Sales Considered in This Cumulative Effects Analysis

In this analysis, lease sales for the Federal OCS and the NPR-A are considered. Although Northstar production from the Federal OCS is small (1,131,639 bbl to May 2002), possible future production from Sale 186 is estimated at 460 MMbbl.

Since December 1979, the USDOI has held nine lease sales in Federal waters of the Beaufort Sea and two lease sales in Federal waters of the Chukchi Sea. The latest Beaufort Sale 195, was held in March 2005. Over 800 leases have been issued in the Beaufort Sea, totaling more than 3.7 million acres. Additional lease sales are scheduled for 2009 and 2011. There have been no active leases in the Chukchi since 1998. Additional lease sales for the Chukchi are proposed for 2007, 2010 and 2012.

About 30 wells have been drilled on Federal offshore leases, with 9 wells determined to be producible. All wells have been plugged and abandoned, because field economics have not favored production. There are 64 active leases on Federal submerged lands in the Beaufort Sea. The Kuvlum and Kaktovik (formerly Hammerhead) units are potentially producible. Kaktovik is estimated to contain 100-200 million barrels of oil (Petroleum News, 2006d). It will be reevaluated in 2008. There are no resource estimates for Kuvlum. The Northstar Unit comprises two Federal tracts. These tracts contain less than 20% of Northstar's estimated 158 MMbbl of oil reserves.

Table 4.7-G. Production, Reserves, and Resource Estimates Used in the Cumulative Analysis[1]

Timeframes and Field or Area	Oil (Bbbl)[1]
Past and Present (total)	**7.37**
Onshore–past	6.69
Offshore–past	0.35
Onshore–present	0.33
Reasonably Foreseeable Future (total)	**12.72**
Discovered Onshore and Offshore	1.57
Undiscovered Onshore	11.15[2]
Total	**20.09**

[1] Production and reserve data are as of December 2003.
[2] Includes approximately 88% of the mean technically recoverable undiscovered oil in Northeast NPR-A (4.05 Bbbl under Alternative C), Northwest NPR-A (3.58 Bbbl), and lands between NPR-A and ANWR (3.52 Bbbl).
Sources: USDOI BLM and MMS (2003), USDOI MMS (2003c), and AOGCC (2004).

From a historical standpoint, only about one-third of the Federal sales originally scheduled in the Beaufort Sea were held, and only a small fraction of the tracts offered in the sales were leased (less than 7%). Few of those leases were actually tested by drilling (30 wells on 20 prospects). Most discoveries (11 wells determined to be producible) were too small or too costly to become viable fields. One field (Northstar, discovered in 1984) started production in 2001, while another (Liberty, discovered in 1982) is being considered for development.

BLM held lease sales in the planning area in the early 1980s. Recent lease sales by BLM include leasing 133 tracts in 1999, and leasing an additional 60 tracts in 2002. Industry has drilled 20 wells, with announced discoveries of gas, oil, and condensate in five wells.

BLM held an oil and gas lease sale on June 2, 2004, for 484 tracts in the Northwest NPR-A, and for 22 tracts that combine lands from the Northwest and Northeast NPR-A along the Ikpikpuk River that had not been offered previously. About 5.8 million acres were offered. Five companies submitted bonus bids totaling $53,904,491 to win rights to develop 123 oil and gas lease tracts. The single largest bid was $13,745,000 for tract D-19 near the Ikpikpuk River.

BLM held an oil and gas lease sale on September 27, 2006, for the Northwest NPR-A. The sale offered 478 tracts totaling 5.4 million acres. Bids were received on 81 tracts totaling approximately 940,000 acres. The sale offered 108 new tracts that were not available in the 2004 sale. Four companies submitted bonus bids totaling $13,763,715. The single largest bid was $2,280,100 for tract 272.

4.7.3.6 Infrastructure and Transportation

Production of any North Slope petroleum reserves would not occur without a means of exporting the production to market. The transportation infrastructure system for any project includes four components: pipelines from the production pads to a CPF, pipeline from the CPF to TAPS, TAPS from Prudhoe Bay to Valdez, and seagoing tankers that travel from Valdez to ports on the west coast of the U.S. and in Asia.

Given the decline of production in existing Prudhoe Bay fields, the existing oil transportation system (including TAPS) is expected to be able to transport oil produced by development of new

reserves on the North Slope, as well as additional enhanced recovery from the Prudhoe Bay fields during the cumulative analysis period. New fields would use infrastructure at the edge of the core area to transport processed crude oil to the TAPS pipeline. This existing infrastructure at the edge of the core area includes the Western Group (including existing Alpine, Kuparuk, and Milne Point infrastructure), which would accommodate new production from the NPR-A; the Central Group (including Northstar and other fields near the Beaufort coastline); and the Eastern Group (including numerous discoveries in the Point Thomson area and adjacent offshore; see Map 3-2).

The cumulative impacts of operating the TAPS transportation system were evaluated in the Final EIS for Renewal of the Federal Grant for the Trans-Alaska Pipeline System Right-of-Way (USDOI BLM 2002). These impacts included consideration of continuing use of the crude oil transportation system to transport current and future production. It also considered the probability and consequence of spills from various elements of the system. The conclusions about the cumulative impacts associated with transportation of crude oil from the North Slope presented in the TAPS Renewal FEIS are equally applicable to this supplemental IAP/EIS, and are incorporated into this cumulative analysis. A copy of the TAPS Renewal EIS can be reviewed on-line at http://tapseis.anl.gov/; the findings are summarized below.

The TAPS Renewal FEIS made the following conclusions on impacts from continued operation of the pipeline and tanker transportation system:

- Paleontology, Air Quality, Transportation, Waste Management, Terrestrial Vegetation and Wetlands, and Cultural Resources – TAPS would have no or a very minor impact.
- Soils and Permafrost – Increased throughput could expand thaw bulbs and ground settlement near TAPS. Reduction in throughput could cause frost heaves. Overall, TAPS would be a minor contributor to cumulative effects related to soils and permafrost.
- Sand, Gravel, and Quarry Resources – The TAPS would be a minor contributor to requirements for these resources.
- Surface Water Resources – Impacts to surface waters would be localized unless an oil spill occurred, in which case impacts could be substantial. The TAPS operation would have a very small effect on surface water quality.
- Groundwater – An oil spill from TAPS or oil development activities could impact groundwater quality to a small or large extent, depending on the spill's size, and location, and the effectiveness of response activities.
- Physical Marine Environment – The marine environment could be affected by spills from tanker and other forms of marine transportation in Prince William Sound or along Pacific transportation routes. Reasonably foreseeable spills would be small, rapidly cleaned up, and of local consequence. Larger, less probable spills could take longer to clean up and result in widespread contamination of the marine environment.
- Noise – All activities would have the potential to produce local impacts on noise.
- Human Health and Safety – No substantial health impacts would be expected from the inhalation of industrial air emissions in the Valdez area. The Valdez Marine Terminal operations contribute to, but are not the sole source of, organic air pollution emissions in the Valdez area. The general public would be exposed to more vehicle emissions over the next 30 years unless additional controls were placed on such emissions. Accidental releases of hazardous materials and spills into the marine environmental also could have small impacts on public health.
- Fish – Risks of large spills with large consequences would be minor; however, a major spill into a waterway could be severe and possibly long term.

- Birds and Terrestrial Mammals – Impacts from many activities could be large in local areas but would be minor on the population level.
- Threatened, Endangered, and Protected Species – Impacts are anticipated to be negligible to minor and are not anticipated to threaten population viability, unless a low-probability, high-volume spill from oil transportation occurred in Prince William Sound or along Pacific transportation routes. Such a spill might cause impacts that would be high on a local level.
- Subsistence – There would be minor impacts on subsistence, except on the North Slope where impacts would be moderate. Contributions from TAPS to these cumulative impacts are expected to be relatively small.
- Sociocultural Systems – In sociocultural systems founded on cooperation and subsistence, cumulative impacts might accompany their continued interaction with modern American society and the continued growth in the importance of a cash economy. However, these changes occurring throughout Alaska are not attributable solely to cumulative actions considered in the EIS. The contribution of TAPS to these cumulative impacts would be relatively small.
- Land Use and Coastal Zone Management – The contribution of the TAPS operation to these cumulative impacts is expected to be relatively small. However, an oil spill to marine waters from marine transportation or from oil production could impact implementation of Coastal Management Plans.
- Recreation, Wilderness, and Aesthetics – Oil or gas spills associated with TAPS operations could impact recreation, aesthetic, and wilderness values. Because spills could result in long-term impacts, aesthetic impacts along TAPS could be major.
- Economics – Continued production of North Slope petroleum reserves, including transportation, would make a substantial, though declining contribution to domestic oil production and would continue to reduce the need for foreign oil imports, thus improving national energy security and the overall balance of trade. Substantial Federal tax revenue would be generated with continued TAPS operation, together with marine and shipbuilding employment and employment in the economy as a whole.

Tanker Traffic and Routes

On November 28, 1995, President Clinton signed legislation (30 USC § 185(s)) that authorized the overseas export of crude oil from Alaska's North Slope in U.S. flag tankers, unless the President finds exports are not in the national interest. Tankers traveling to the Far East could carry up to 1.8 MMbbl each; however, such shipments are highly speculative because they depend on opportunities for short-term contracts. The route to the Far East would keep the tankers more than 200 miles offshore of the Aleutian Islands, a distance that would minimize the potential for oil spills due to strandings and protect the biological resources of the Aleutian Chain from pollution. In addition, there are LNG shipments from an LNG plant at Nikiski, Alaska. Every 10 days, the Nikiski plant loads a tanker with 80,000 cubic meters of LNG for Tokyo, which it has been doing since 1968 without a major incident. Because LNG boils off and disperses quickly when exposed to normal air temperatures and winds in the North Pacific, it is not a major environmental threat along the tanker route.

4.7.4 Advances in Technology

When exploration of the North Slope began, knowledge about of the effects of exploration and construction techniques on permafrost was limited. From early exploration through the 1950s, trails often were cut directly into frozen ground. Large tractors and tracked vehicles traveled

over thawed ground in the summer, often leaving deep ruts, and sometimes road builders removed the vegetation mat completely, causing deep thermokarst (Bliss and Wein 1972, Hemandez 1973, Chapin and Chapin 1980). Trails commonly became wetter than the natural habitat and were colonized by species more adapted to wet sites. Higher biomass and changes in nutrient concentrations occurred in the trails (Chapin and Shaver 1981). At times, subsidence and erosion created trails as deep as 16 feet (Lawson et al. 1978). Some old trails and seismic surveys made by government contractors in the 1940s are still clearly visible because they are deeply rutted, often flooded, and filled with vegetation that is quite different from the surrounding tundra (Hok 1969, 1971; Lawson et al. 1978).

In the 1960s, peat roads were built by scooping the active layer from two sides of an area and piling it in the center to form an elevated surface. This method also resulted in severe thermokarst. By the 1970s, gravel had replaced peat in road construction. Now in many cases, ice is used.

Over the past 2 decades, new technologies have been developed and applied to exploration, development, and production on the North Slope. Some technologies, such as the use of ice roads and ice pads for exploration wells and the Arctic Drilling Platform, are unique to the Arctic and were largely developed in Alaska. Other advances, such as the use of coiled tubing, 3-D seismic-data acquisition, horizontal and multilateral drilling, measurement while drilling, low ground-pressure vehicles (Rolligons), and remote sensing, were developed elsewhere and adapted for use on the North Slope. Although some of those newer technologies have been used extensively, and the newer fields (such as the one at the Alpine field) use them almost exclusively, older technologies are still integral parts of the older portions of the Prudhoe Bay and Kuparuk fields. An understanding of the development and use of newer technologies is important in understanding what effects to resources accumulate on the North Slope, and the likelihood and magnitude of these effects in the future.

4.7.4.1 Seismic/Off-road Travel/Exploration

The new exploration-related technologies reduced the overall use of gravel and presently eliminated it from the exploration-drilling process, provided data for better siting of facilities, and reduced the number of wells required to find and evaluate a new field. Although the physical effects have been greatly reduced by the use of these technologies, there are still valid concerns regarding the potential for some amount of damage to the environment.

The environmental effects of the older road and pad construction techniques and seismic trails are matters of concern. In some instances, the effects have not diminished with the passage of time; in others, a natural but slow recovery is occurring. The visual impact, in some cases, will be evident for years, if not for decades.

The density of 3-D seismic activities can cause short-term visual impact. In areas where there is little snow cover or steep vegetated terrain, damage to the tundra and shrubs can be locally significant and long lasting. Long-term studies of the trails built for the closely spaced 3-D acquisitions are required to document the potential effects. Improvements in 3-D seismic-data acquisition and other exploration technologies allow geologists to identify higher quality prospects and to improve success rates by as much as 50% or more. In 1970, the success rate for exploration wells in the U.S. was about 17%. In addition to the advances in data quality and acquisition procedures, there have been important advances in the engineering of the vehicles used to move the camp equipment and to acquire the data. The major changes have been in the development of new "light-weight" rubber tracked caterpillar-type vehicles and vibrators that do

less damage to the tundra and shrubs than the older vintage steel-tired vehicles. With the use of 3-D seismic-data acquisition, success rate increased to 48% in 1997 (USDOE 1999, Revkin 2001).

Three-D seismic technology was introduced about 25 years ago. Data, acquired in a grid-like manner with the individual lines spaced only a few hundred feet apart, are computer manipulated to create multidimensional representations of the subsurface. The result is a far better understanding of the geologic structures and continuity of the potential hydrocarbon-bearing formations. As with the older generation 2-D seismic data, onshore 3-D seismic data are acquired during winter, after freeze-up. Vibrators are used and these energy sources and the crews, camps, and other support facilities are carried on and/or are usually towed by low-impact tundra travel vehicles (Lance 2000). Most offshore 2-D and 3-D seismic data are acquired during the open water season using airguns rather than vibrators. Some offshore data, in the area of bottom-fast ice, are acquired during winter using land technology.

The older, land-based 2-D seismic technology consisted of long, intersecting seismic lines that used either dynamite or vibrators as the energy source. In the early stages of acquisition on the North Slope, much less care was taken to protect the tundra from damage during data acquisition. Damage, then as now, can result from inadequate snow cover and inappropriate equipment.

Offshore seismic data are acquired using patterns and spacing similar to those used in onshore acquisition. These data can be acquired only when the sea is relatively ice-free and boats can maintain long uninterrupted traverses. A high noise level is associated with marine acquisition, and it negatively affects marine organisms, especially whales.

Four-D visualization adds the element of time to 3-D seismic databases. A reservoir's fluid viscosity, saturation changes, temperature, and fluid movements can be analyzed by time-lapse monitoring in three dimensions (USDOE 1999). The time-lapse picture is built out of data re-recorded, compared, and plotted by computer onto the 3-D model. Additional data, such as well logs, production information, and reservoir pressures, may be integrated into the time-lapse imagery. The resulting information provides geologists and others with data that are valuable for both exploration for and management of existing resources. The exploration element comes from the greater ability to predict the best locations for exploratory drilling.

The 3-D seismic-data acquisition and 4-D visualization technologies provide a number of environmental benefits (USDOE 1999). They include more accurate exploration well-siting that reduces the number of dry holes, the number and length of ice roads, and the number of ice pads that have to be built; generation of less drilling waste and decreased volumes of materials, thereby lessening the possibility of a spill or other accident; better understanding of flow mechanics so that less water is produced relative to oil or gas; and increased ability to tailor operations to protect sensitive environments. Overall, fewer wells are required in order to evaluate and produce the reserves.

Nonetheless, considerable concern has existed regarding the effects of any seismic activity conducted either on land during winter or at sea during the open water season (Van Tuyn 2000). Land-based seismic-data acquisition with its large vehicles and numerous traverses across the tundra has left scars of the vehicle paths, some of which have been slow to heal and recover. At sea, migrating bowhead whales have been deflected by noises generated by seismic exploration and drilling.

The 3-D seismic-data acquisition programs require more closely spaced grids, a few hundred feet between lines as opposed to several thousand feet with standard 2-D seismic programs. This closer spacing has the potential to affect a greater amount of the tundra surface. These trails are often highly visible the following summer, in part because the old dead vegetation has been flattened by the vehicles and the green new vegetation can be more readily seen in sharp contrast to the undisturbed surrounding areas.

The closer spacing of the seismic traverses may also increase the risk that denning polar bears may be disturbed. This risk could be lessened by studies of bear denning sites and planning the acquisition programs accordingly.

Ice Roads and Pads

Arctic tundra is easily disturbed and slow to recover from damage. Disruption of tundra may also have a pronounced effect on permafrost and result in thawing and erosion. Historically, roads to exploration well sites were built of peat, bladed bedrock, or gravel, causing long-term damage to tundra that remains evident after 40 or more years. Drilling pads were similarly built of gravel or bulldozed bedrock in some areas of the NPR-A during the Navy exploration efforts in the 1940s and 1950s. Because of these factors, and potential damage from transporting equipment across the tundra either in the summer or winter, ice roads have replaced gravel roads and have become the means of access to most isolated drilling locations. In a similar fashion, ice pads have become the standard for exploration drilling sites, eliminating the need for gravel to build pads and cleanup after drilling. All onshore exploration drilling is done during winter and all materials necessary for drilling a well, including the drilling rig, are moved to and from well locations on ice roads.

An ice road 6 inches thick and an average 30 to 35 feet wide, would require 1 million to 1.5 million gallons of water per mile of length (Van Tuyn 2000); ice roads on the North Slope are generally 12 to 18 inches thick. Frequently, exploration activity within a specific area requires more than one drilling season; therefore, more than one ice road may be built from the staging area(s) to the same drilling site or prospect. To avoid possible damage from multiyear usage of the same area, any subsequent ice road is offset by at least a road width from previous ones.

A 6-acre drilling pad, 12 inches thick, would require approximately 500,000 gallons of water (Van Tuyn 2000). The ice pads provide a solid, stable base from which to drill an exploration well. Upon completion and abandonment or testing of the well, the rig and all support facilities are moved off location and the pad is allowed to melt. The result is a very low impact operation, and usually the only indication of the drilling activity is the abandoned wellhead.

In special situations, specifically where drilling and evaluation are expected to require either an extended drilling season or two drilling seasons, insulated ice pads have been utilized. BP Exploration used such a system when drilling the Yukon Gold No. 1 and Sourdough No. 2 wells in the 1993-1994 drilling season (USDOE 1999). A 190- by 280-feet ice pad was built in March 1993 and covered with wind-resistant insulating pads. The pads remained in place over the summer and were removed in October. Drilling began in mid-November, 2 months ahead of conventional Arctic practice. With this advanced drilling start, the Yukon Gold well was completed, and the rig moved to the Sourdough site and the well completed, all in the same season. This would have been impossible with a conventional ice pad.

To save time on equipment move-in, Phillips Alaska stacked a rig over the summer west of Teshekpuk Lake (120 west of Kuparuk) on an insulated ice pad during 2003-2004. The pad of

ice was constructed toward the end of the winter and covered with wind-resistant insulating panels over the summer months. The drilling rig was then moved to the insulated pad site the following winter. A drilling season can be increased by 50 to 70 days by employing this method (CRS Report for Congress, 2006).

There is the potential for some level of short-term damage in areas that have either experienced low snow fall or removal of snow by high winds, thus creating substandard snow cover conditions. However, in most instances, there is little evidence of either the ice road or ice pad once the snow cover is gone.

The use of ice road and ice pad technology reduces the need for gravel during the exploration phase of oil and gas activity. Smaller volumes of gravel are mined during the history of a given field, less area is covered by gravel, and there is little recognizable damage to the tundra. The use of an insulated pad allows the drilling of more wells in a single season, reducing the need to build ice roads in two seasons to serve the same general area.

The older technologies had greater potential to seriously disrupt tundra, thaw permafrost, and mar the viewscape. These effects can persist for many years and many damaged sites have not been adequately remediated. Although the use of ice roads and pads has largely eliminated those problems, a different set of potential effects has been identified. Insulated ice pads have some degree of influence on the underlying tundra, because the area loses a growing season, but these effects have not been studied.

The construction of ice roads and pads relies on a ready and plentiful supply of water. Water is withdrawn from rivers or lakes, and existing ice is crushed or chipped and spread along the prescribed roadway or pad site. Concern has been expressed that the extraction of such large volumes of water may endanger fish and drinking water resources. Areas such as the Arctic National Wildlife Refuge have low lake densities and a reliable source for water to build ice roads/pads may not be present. At this time, there are few reliable data that address the controversy over the appropriate use levels for water in the construction of ice pads/roads.

Rolligons and the Arctic Drilling Platform

Potential problems associated with exploration drilling in areas with limited freshwater supply or shortened ice road seasons may be alleviated by the use of low ground-pressure vehicles (Rolligons) and the Arctic Drilling Platform. Low ground-pressure vehicles put 1 to 5 pounds per square inch (psi) of footprint pressure on the tundra. The vehicles with 1.0-2.0 psi are used for building snow trails. (Lewellen Arctic Research and Polar Alpine, Inc., 2000). Once the lowest pressure vehicles have compacted the trail, higher pressure vehicles can be used. This can effectively extend the off-road winter season on the North Slope. Low-ground pressure vehicles have been used to move drilling rigs to remote locations. Their primary use would likely be to access locations that are far from current infrastructure and where the economies of the operation favor their use over the costs and the associated delays of building an ice road.

Anadarko field-tested a new drilling system, the Arctic Platform, which has potential for use in the NPR-A, although this is unlikely due to the "pioneering" nature of this technology. The Arctic Platform is like an offshore platform, but is used on land. A self-contained drilling system and crew quarters sit atop a deck made of interlocking modules that rest on pilings set into the permafrost below the tundra. The platform is elevated approximately 12 feet off the tundra, eliminating the need for gravel or ice pads, and rests on a base of shallow containers that capture any deck fluids or other spillage. Surface use of this technology could allow operators to

perform exploration drilling outside the winter season, since ice pads would not be required. This technology could also allow access to remote areas, to areas where water to build ice roads is scarce, and to areas where steep grades make it difficult to set a rig. The Arctic Platform concept may have promise for exploration drilling and as a production unit. At this time, however, it is still in the experimental or developmental stage and, consequently, for the purposes of this analysis, it is assumed that this drilling system will not be used.

Seismic exploration is expanding southward into the foothills of the Brooks Range. Current technology and regulations governing seismic-exploration permits and other off-road travel have reduced but not eliminated damage to the tundra. The nature and condition of permafrost in the foothills is poorly characterized, and the hilly topography increases the likelihood that vehicles would damage vegetation, especially on knolls and riverbanks, causing increased erosion, exposing bare soil, and creating thermokarst. In addition, future exploration would be carried out in a climate that is likely to continue to warm, with milder winter temperatures and shorter periods of freezing.

4.7.4.2 Drilling and Completion Technologies

An oil reservoir is part of a porous and permeable layer of rock in which the oil is trapped. On the North Slope, each production well is designed to produce from a subsurface area of at least 80 acres. Wells are located on gravel pads and are drilled vertically through approximately 2,000 feet of permafrost. Once through the permafrost, the bit is directed toward the desired bottom hole location. The number of wells per pad generally ranges from 16 to 40 (BP Exploration Alaska, Inc. and ARCO Alaska, Inc. 1997). The size of the pad and associated facilities is largely governed by the spacing between wells, and the number of pads is a function of the size of the area that can be drained by the wells on a pad. Historically, production wells were both straight or deviated holes and the number per pad was limited; hence, the number of pads needed to drain a specific area was high. The lateral reach of deviated holes rarely exceeded the true vertical depth (TVD) of the well. New technologies have done much to improve the lateral reach of a well and to reduce the size and number of well pads.

The technologies developed over the last 2 decades have greatly reduced the size of the footprint left when developing an oil field. Wells may be much more closely spaced, far larger areas developed from a single small pad, the mud systems are less toxic, and reserve pits have been eliminated.

Coiled Tubing

The use of coiled tubing is particularly valuable in sensitive environments such as the North Slope. Coiled tubing technology is quieter and has far less impact on a drilling site than conventional equipment (USDOE 1999). The technology dates from the 1950s, but only after rapid technological advances in the late 1980s did it come into common use. The tubing is mounted on a large reel and is a continuous flexible coil that is fed into the hole. The use of coiled tubing does not require the repeated "tripping" out of the hole to add additional pipe segments. One of the byproducts of coiled tubing drilling is a significant reduction in the volumes of drilling fluids compared with conventional drilling. Coiled tubing mud volumes are commonly less than half those required or generated by conventional drilling practices. In many wells, conventional methods are used to drill the initial hole and then coiled tubing is utilized to drill horizontal segments or multilateral completions. The coiled tubing technology is also commonly used for slim-hole drilling (i.e., a rotary borehole of 5 inches or less, or a drill hole of the smallest practical size) and reentry projects.

The use of coiled tubing technology has substantial environmental advantages over the conventional drilling technology. The primary benefits include: reduced mud volumes and drilling waste; cleaner operations, no connections to leak mud; reduced operations noise; minimized equipment footprints and easier site restoration; reduced fuel consumption and emissions; reduced risk of soil contamination due to increased well control; and better well-bore control. These advantages clearly support the use of coiled tubing whenever it is technically feasible. Many of the newer fields, such as the Alpine field, use this technology almost exclusively in conjunction with extended-reach horizontal drilling. No detrimental environmental effects are known to be associated with the introduction of coiled tubing technology to the North Slope.

Horizontal Drilling

Horizontal drilling became a reality in the 1970s due to advances in computers, steerable down-hole motor assemblies, and measurement-while-drilling tools. A horizontal well is drilled from an initially vertical well-bore at an angle between 70 and 110 degrees. Vertical, or near vertical wells, drain oil from a single hole and have limited contact with the oil-bearing interval (usually limited to the vertical thickness of the rock unit). Horizontal wells penetrate the formation up to 5 miles or more from the vertical well bore, allowing more oil to drain into the well.

The results are a greater number of wells per pad, closer well spacing on the pad, and fewer well pads than using the old technology. Well spacing has decreased from 120 feet or more to as little as 10 to 15 feet between wells (BP Exploration Alaska, Inc., and ARCO Alaska, Inc. 1997). Pad size and radius of reach of the wells on the pad have undergone remarkable changes since the start-up of the Prudhoe Bay field in the 1970s.

The marked increase in drillable area per pad, as demonstrated at the Alpine field, is largely due to the extensive use of horizontal drilling technology. The environmental benefits include smaller footprints requiring less gravel and fewer wells to produce the same volume of hydrocarbons. These more effective drilling programs require less water and subsequently generate less drilling waste. Horizontal drilling results in smaller and fewer pads than did the older technologies, but gravel is still needed and effects on tundra and permafrost may result from gravel mining and emplacement. The closer spacing of well-bores has the potential to increase the rate at which permafrost thaw bulbs form, reducing surface stability and causing subsidence.

Multilateral Drilling

Multilateral drilling, a variant of the horizontal drilling technology, creates an interconnecting network of separate, pressure-isolated and reentry accessible horizontal or high-angle boreholes surrounding a single major borehole (USDOE 1999). Multilateral drilling is most effective in reservoirs that have isolated accumulations in multiple zones, have oil above the highest perforations, have lens shaped pay zones, are strongly directional, contain distinct sets of natural fractures, and are vertically segregated with low transmissibility.

The environmental benefits are similar to those achieved with horizontal drilling and include fewer drilling sites and smaller footprints, less drilling fluids and cuttings, and protection of sensitive habitats and wildlife. Multilateral drilling poses no additional recognized risks to the environment other than those associated with horizontal drilling.

Measurement-While-Drilling (MWD)

Conventional down-hole logging practices consist of running a variety of remote sensing tools down a borehole prior to setting the surface casing, before any intermediate casing strings, and prior to completing the well at total depth. These tools are attached on wire-lines and are lowered into the uncased hole and pulled back to the surface. The tools record specific types of data as they are withdrawn from the hole. These data are then used to evaluate the rock type, reservoir properties, hole integrity, and the other features concerning the physical environment of the well-bore. The procedure is routine, but it can be a risky because irregularities in the hole can result in stuck or even lost tools. Conventional logging can be especially risky in a highly deviated or horizontal hole where there is an increased probability that the tool, while being pulled out of the hole, may become snagged on a resistant rock projection or become buried by loose debris collapsing into the hole.

Additionally, these important data are not available to the geologist until some time after the well or interval has been drilled. This delay may vary from hours to days or even weeks. An example would be the desire to correlate the drilled section with that seen in a well some distance away, in order to predict a coring point or anticipate stray high-pressure sandstone.

Measurement-while-drilling (MWD) technology can provide data virtually as the intervals are drilled. Additionally, sensors provide directional information and other key data that facilitate more effective geosteering and trajectory control (USDOE 1999). The recording sensors and other necessary equipment are housed in the drilling assembly at the bottom of the pipe-string, just a few feet above the drill bit.

Because of its real time capability, the MWD technology can be used to avoid formation damage by alerting the rig crew of problems before they become too serious to correct; similarly there is a reduced possibility of blowouts and improved overall rig safety. This technology is also a contributing factor in the reduction of drilling waste volumes because it facilitates horizontal and multilateral drilling practices and provides better well-bore directional control. The technology also reduces the potential for loss of a tool assembly, reducing waste and shortening the duration of the drilling process.

Light Automated Drilling System (LADS)

As discussed earlier, the construction of ice roads and ice pads in remote areas requires an abundant water supply. There is legitimate concern regarding means of access in areas that lack sufficient water and/or fresh-water ice to build roads or if global climate change were to prevent the use of ice roads.

A possible solution to this problem, the Light Automated Drilling System (LADS), is in the research phase and is being considered for use on the North Slope. This potential drilling system is expected to be a light-weight drilling rig that can be easily broken down into several components and transported across tundra in winter by light impact vehicles that would not require ice roads. This system, or others like it, could be adapted to work in areas that lack sufficient water for ice roads or during mild winters when it would not be possible to build an ice road, transport a rig to a drilling location(s), and return it to the staging area.

The principle benefit of LADS would be to reduce the need for water to build ice roads. The primary drawback from the environmental perspective would be the increased risk of damage to the tundra while transporting rigs between locations in the absence of adequate snow cover.

The same concerns exist as are presently expressed for seismic activity, but on a much reduced scale.

4.7.4.3 Development and Production

Production and associated operations are the longest-term activities in an oil field. The life of major oil fields on the North Slope could be expected to be on the order of 30 to 40 years, occasionally as much as 50 years. During this time pipelines, production facilities, waste disposal systems, water treatment plants, injection facilities, road systems, and other specialized units continue to operate.

Industry attempts to produce the maximum amount of oil/gas at the least cost in order to remain competitive and viable in the event of competition for funding or a low oil/gas price environment. The most cost efficient technologies are the obvious choice of the operators. It is not surprising that in the early phases of development and production some of these choices have proven to be less than optimal from an environmental perspective. The use of reserve pits for the disposal of used drilling muds, cuttings, and other waste is one such example.

Today, on the North Slope, as fields continue to be discovered, developed, and produced, there continues to be the need for new pipelines, production facilities, waste disposal wells, etc. To reduce the environmental effects of these activities, new technologies have been developed or adapted for use on the North Slope. New methods do not eliminate the need for gravel, water, and other materials, but they reduce their use and cause fewer disturbances, therefore reducing the potential negative effects associated with wastes and road and pipeline construction.

Enhanced Oil Recovery

This technology involves the injection of formation/source water, natural gas, and miscible fluids into the producing reservoir to maximize recovery of hydrocarbons. In this process, not only is more oil recovered per well, but much of the waste water associated with oil production is reintroduced into the reservoirs from which it was produced. Many problems that formerly were handled by surface or reserve pit disposal techniques are solved.

The principal environmental benefits are greater recovery of oil without a proportionately greater number of wells and their associated waste, environmentally friendly disposal of produced water, and reduction of emissions that would be associated with the flaring of excess produced gas. Few negative environmental effects are associated with Enhanced Oil Recovery. The primary concern is in regard to spills of produced water and the remote possibility that a reservoir may be over-pressured through the injection process, causes fracturing to the surface, and allows oil and other fluids to escape to the pad and/or tundra.

Waste Disposal

From the 1940s to the 1980s, most well-associated wastes were either stored in reserve pits or handled through other surface disposal means such as incineration. The reserve pits were prone to seepage and spills, and they contained undesirable metals and volatile organic compounds. These did, and still do present environmental risk, especially at old, unclosed remote exploration sites.

The reserve pit closure program was instituted in 1996. To date, 50% of approximately 600 reserve pit sites have been closed. Down-hole disposal of wastes by injection into subsurface disposal intervals is utilized in all present-day exploration wells and producing fields. This

mode of waste disposal is an effective and non-contaminating method of removing many unwanted materials from the surface environment. The grind-and-inject project was undertaken to dispose of drilling muds and cuttings stored in reserve pits. Other wastes processed through the grind-and-inject plant include Class II, RCRA-exempt oily wastes, and drilling muds and cuttings from ongoing drilling operations.

Annular injection is an environmentally safe method of disposing of drilling muds and cuttings, and the injection of Class I and Class II materials into discrete disposal zones has provided a mechanism for the handling of produced formation waters and other associated wastes (NRC 2003). However, a large number of unclosed reserve pits remain at remote exploration well-sites. No adequate plan is in effect to handle the possible pollution and resultant damage from poorly sealed and covered pits. The annular injection process has some potential to create or take advantage of poor casing or cement jobs and result in leakage to the surface. This has occurred on several occasions, but with no contamination of permafrost. Worries regarding subsidence and marine contamination have been expressed, but the existing evidence indicates that subsidence is not a concern and disposal units are effectively and naturally isolated from any contact with the ocean or seafloor.

Gravel Use

Gravel in the area of Alaska north of the Brooks Range has been used for a variety of construction and maintenance purposes. These historical uses include construction of the following:

- Dalton Highway/Haul Road in support of the development of the North Slope oil fields and TAPS;
- Pads for camps, exploration drilling, development and production drilling sites, and operations and maintenance facilities;
- Airports in oil field areas and in the communities of the NSB;
- Roads in oil field areas and in the communities of the NSB;
- Man-made islands for offshore exploration drilling and for development and production facilities;
- Docks and causeways; and
- Beach nourishment in several of the NSB communities.

From 1974 to 1999, more than 205 million tons of gravel was mined to meet the industrial and community construction and maintenance needs in the area that includes the Brooks Range, the area north of the Brooks Range to the Beaufort Sea coast (the North Slope), the Chukchi Sea coast north of Cape Krusenstern, and NSB communities (NRC 2003). Most of the gravel was mined from the floodplains of rivers. About 180 million tons of the gravel (88% of the total) was mined from 1974 to 1985. During this time, the Haul Road/Dalton Highway and pads, roads, and airfields were constructed for the facilities to develop the Prudhoe Bay, Kuparuk River, Lisburne, Milne Point, and Endicott oil fields. From 1986 to 1999, the amount of gravel mined annually in the Northern Region ranged from 0.56 to 4.5 million tons.

The portion of the oil-field network that is connected by roads stretches to 60 miles from the Endicott field in the east to the Tam oil field in the west. Most of the expansion of the road network was done before 1988, the development phase of the field, during which the rate of growth was about 24 miles per year. Since 1988, the rate of growth in the road network has been about 3 miles per year (NRC 2003).

The total gravel-covered area increased from about 20 acres in 1968 to about 9,200 acres in 2001 (NRC, 2003) The rate of gravel placement declined noticeably after 1988, because the main road network and most of the pads in the Prudhoe Bay and Kuparuk oil fields had already been built. The average rate of growth was 780 acres per year before 1988 and 57 acres per year after 1988. Most of the gravel-covered areas are associated with onshore drilling and construction pads.

Offshore gravel islands support production operations. The Endicott islands are connected to each other and to the mainland by a 5 mile causeway and are situated in waters generally less than 7 feet deep (AOGA 2001). The shallowness of the Beaufort Sea in the Prudhoe Bay prevents large vessels from docking there. Three gravel causeways were constructed to facilitate docking, to provide access to artificial-gravel production islands, and to draw seawater for waterflooding.

The ADFG, Habitat and Restoration Division, developed guidelines for siting, design, operation, and reclamation of North Slope gravel pits. The area disturbed by gravel mines and fill placement is a fraction of the area north of the Brooks Range. The North Slope covers about 57 million acres, and the ACP covers about 13 million acres (Gilders and Cronin 2000). The area that would be disturbed by gravel mines and fill placement in 2010, assuming construction of Alpine satellites CD-5, CD-6 and CD-7 is projected to be about 18,680 acres, or about 0.14% of the ACP (Table 4.7-H).

Table 4.7-H. Past, Present, and Near Future Production and Development Total Disturbed Areas for the North Slope (in acres)

	1968	1973	1977	1983	1988	1994	2001	2010[1]
Gravel footprint areas	20	1,714	3,240	6,940	8,446	8,690	8,998	9,680
Other impacted areas[2]	308	1,388	1,552	1,694	1,698	1,762	1,765	1,900
Gravel mines	25	4,766	5,146	5,756	6,241	6,247	6,364	6,430
Dalton Highway	332	332	332	332	332	332	332	332
Total disturbed area	685	8,200	10,270	14,722	16,717	17,031	17,459	18,342

[1] Includes disturbed areas associated with the Alpine Satellite Development.
[2] Disturbed area around gravel pad, peat roads, tractor trails, exploration roads, gravel pad removal site, etc.
Sources: NRC, 2003; BLM, 2004

Surface deposits within the NPR-A consist mostly of fine-grain clay, silt, and sand. Gravel is located along the slopes of the Brooks Range, the Colville River, and some scattered areas along the Arctic coast. West of the Colville River, gravel sources may become increasingly rare because of the low-relief, poorly drained character of the ACP. Meandering rivers have low energy and a low capability of transporting coarse clastic material (gravel) from higher elevations. The Brooks Range is far from the coast on the western North Slope. Consequently, suitable gravel sources are far more difficult to locate. Because long hauls are often required to bring in gravel, gravel from existing work/drill sites is reused (Gryc 1985). This lack of gravel would be an important consideration in the development of permanent oil and gas facilities west of the Colville River. Although there are no specific proposals, there is ongoing discussion about the potential need for inter-community roads west of the Colville River. Such roads would also require large amounts of fill material (gravel and sand), since gravel roads require 60,000 cubic yards per mile. (For this Supplemental IAP/EIS, such a community road is not considered reasonably foreseeable).

In general, North Slope gravel usage for oil fields has been declining. Large fields (such as Prudhoe Bay and Kuparuk) that require a large number of production well pads are no longer being discovered. There also is a trend toward consolidating facilities and using technological advances that minimize the surface area disturbed (Gilders and Cronin 2000). Overall, the footprint of oil fields is getting progressively smaller because wells are closer spaced and on-pad structures are minimized. A smaller footprint equates to less gravel use.

Other developments that have reduced the amount of gravel needed to develop or maintain oil and gas production facilities have utilized the following practices:

- Use of ice pads instead of gravel for exploratory well-drilling pads (onshore and offshore in shallow waters, where appropriate);
- Use of mobile steel or concrete bottom-founded structures to drill exploratory wells in shallow waters;
- Use of ice roads instead of gravel roads for pipeline construction;
- Development of fields without a gravel road connection to the Prudhoe Bay/Deadhorse area (Badami and Alpine);
- Reduction of the spacing distance between development wells, which reduces the size of the development pads;
- Use of extended-reach drilling, which reduces the amount of gravel needed to develop new reservoirs that lie near established facilities;
- Recycling of gravel from roads, airfields, or pads that are no longer used; and
- Use of clean drill cuttings in place of gravel.

Future oil field development would be based on refined variants of the Alpine model. Pads would be small and few in number and construction would be largely a winter activity with transportation via ice roads. The use of gravel would be appreciably reduced but would likely still be necessary to connect satellite developments with the larger pads that contain housing, airstrip, and the production facility.

Pipeline Construction and Spill Prevention

Among the standard practices utilized in the construction of pipelines are gravel maintenance and construction roads, elevated river crossings, and block valves to reduce the likelihood and sizes of leaks and spills. Recent developments have lessened the environmental effects of pipeline construction, the hazards to the pipeline due to flooding, the probability and severity of leaks, and impediments to caribou movement. These new approaches were all used in the design and construction of the Alpine field oil pipeline (Lance 2000), which was built largely during the winter using ice roads. The lack of a gravel maintenance road removes one potential barrier to caribou movement, and reduces the volumes of gravel required for the Alpine field-like projects and the amount of tundra impacted by burial.

The Colville River pipeline crossing posed a considerable challenge. During breakup and the associated flooding, the river is almost a half-mile wide and could destroy an above ground pipeline or erode deeply enough to expose and rupture a line buried in a surface trench. ARCO Alaska, Inc., elected to use horizontal directional drilling to position the pipeline deep beneath the river channel (Lance 2000). More than 4,000 feet of pipeline were placed 100 feet below the river.

After conducting an oil-spill isolation strategy study that reviewed ways of meeting Federal leak-containment regulations, ARCO Alaska, Inc., elected to use 39 to 46 feet high vertical loops on the Alpine field pipeline in lieu of the more conventional block valves. The study concluded that when used in tandem with emergency pressure-letdown valves or divert valves, vertical loops would contain drain-down-related spills as well as block valves, while offering operations and maintenance efficiencies (Pavlas et al. 2000).

The loops are better than manual block valves for reducing catastrophic failures and they provide protection levels similar to those achieved by remotely-actuated valves for leaks of all sizes. They are not potential leak sites, as valves are, but they do not provide any substantial benefit over block valves for pinhole leaks. With approval from the Department of Transportation, the loops were placed at river crossings and high points along the line.

These new pipeline construction methods greatly reduce the environmental effects on tundra, provide for a safer line, and lessen the probability of spillage due to river-induced pipeline damage. They also more effectively limit the size of catastrophic spills. However, the placement of a pipeline at depth beneath a river could make detection and cleanup of a spill in the buried segment difficult. The preexisting and predominant North Slope pipeline technology presents impediments to caribou movement when in close proximity to roads, and river crossings are sites of potential severe environmental consequences if a spill occurs. The accumulation of effects of continued construction of pipelines and road systems could increase the magnitude of displacement of the calving caribou away from the coastal strip and prime forage/insect-relief areas.

Remote Sensing

Remote-sensing techniques such as infrared photography, have been used to design and locate roads and facilities, such as development facilities and ice roads and ice pads, to reduce effects on the environment. Satellite infrared photography has been utilized to facilitate habitat mapping in the Alpine field (Lance 2000). The environmental benefits come from the avoidance of critical habitat and better design of facilities that must be placed within less than ideal locations. No negative consequences have been identified with the use of this technology.

4.7.4.4 Abandonment and Restoration

The factors leading to a decision to abandon a field can differ for each field, but declining production rates and oil price are usually the two key considerations. Abandonment occurs when the field is no longer economically viable.

To date, very little abandonment (except for single exploration or development wells) has occurred anywhere on the North Slope. According to the U.S. General Accounting Office (GAO; 2002), as of December 2001, no production pads have been abandoned, as all of the production wells associated with the pad must first be plugged and abandoned, which has not taken place. Restoration of other types of facilities, such as gravel extraction sites and older exploration pads, has taken place at a small scale at several locations on state lands on the North Slope outside of the planning area (Jorgenson et al 1992; McKendrick et al 1992; Herlugson et al 1996; McKendrick 1996). These restoration efforts are being closely monitored in an effort to determine the most appropriate and effective methods for restoration.

As the infrastructure ages or is abandoned, other unintended environmental effects can result. Aging increases the likelihood of failure, which can lead to accidental discharges (spills) or to

other accidents. Abandoned roads and other structures can degrade from melting permafrost and continue to alter the visual environment, especially if the climate continues to warm.

Most North Slope oil-field equipment dates from the last quarter of the 20th century. Components that could fail include pipelines through corrosion, subsurface safety valves, and safety systems to suppress fires and explosions. The older oil-field areas, such as Prudhoe Bay, will be most susceptible to aging. Thus, age-related maintenance demands will increase as oil revenues from declining oil fields decrease. As an aging field's production declines and the cost of extracting oil increases, the economic incentive to postpone or eliminate maintenance and replacement will increase. The environmental effects of aging infrastructure will depend on interactions between the economics of declining fields, increased replacement and maintenance costs, the regulatory regime, and other factors equally hard to predict.

The oil industry and many public landowners use the term "dismantlement, removal, and restoration," or DR&R, to refer to dismantlement and removal of infrastructure and restoration of the land following removal activities. The DR&R can range from complete restoration to a natural state approaching original condition to simply removing structures (GAO 2002).

The State of Alaska has adopted general DR&R requirements that contain no specific stipulations on what infrastructure must be removed or to what condition the lands must be restored once oil production ceases (GAO 2002). The state specifies that oil companies must return the land to the condition that is satisfactory to the state, a condition that has not been defined. Other entities, such as the USACE, NSB, and Native landowners, have the authority to impose DR&R requirements, but generally defer to the state to impose these requirements. Under existing funding mechanisms, only a small portion of the funds needed would be available to dismantle, remove, and restore oil and gas facilities. The State of Alaska requires companies to post bonds or other forms of financial assurance as a condition for obtaining a lease and drilling permits. However, companies are required to maintain only $500,000 in assurances to cover all of their leases in the state; it is estimated that it will cost billions of dollars to conduct DR&R for existing infrastructure on the North Slope.

BLM's overall restoration goal for the NPR-A is to return it to its previous use, which includes fish and wildlife habitat, after oil production ceases; however, BLM has yet to develop specific DR&R requirements for companies to use. On the other hand, the MMS, has specific DR&R requirements for offshore drilling. Both agencies have the authority to require financial assurances to fund DR&R. The MMS has an escalating bond structure that considers, among other things, the future costs of reclamation, increasing the likelihood that future DR&R costs would be covered by the bond.

By the terms of Federal and state leases and permits, it is the responsibility of the lessee/applicant to remove facilities and rehabilitate the land upon field abandonment or expiration of a lease or oil and gas-related permit to the satisfaction of the land management authority (Lease Stipulation 58 [Alternative A]; Lease Stipulation G-1 [Alternatives B, C and D]). Abandonment plans would be developed at the time of abandonment or expiration of the lease or permit, in consultation with appropriate local, state, and Federal agencies, and would be subject to Federal (BLM, USACE and/or USEPA) and state approval. The AO would take into consideration alternative uses for the infrastructure and the impacts of removing infrastructure and alternative means to rehabilitate the land. Federal agencies would undertake appropriate NEPA analysis of any such abandonment and rehabilitation decision at the time of abandonment or expiration of a lease or permit. All costs associated with abandonment, removal, and restoration are the responsibility of the lessee.

The AO may require any range of abandonment and rehabilitation steps for roads. For gravel roads, these steps could include: 1) leaving roads in place and maintained for continued use; 2) revegetating roads either naturally or actively by the permittee, removing bridges and culverts, and breaching roads to facilitate more natural water flow; or 3) removing roads, with gravel either being placed back into gravel pits or reused for other development in the area.

Abandonment of the proposed pipelines could include demolition and removal of the facilities and restoration of disturbed ground. It is anticipated that pipeline removal would be consistent with that described for TAPS in the TAPS Right of Way (ROW) Renewal EIS. Based on TAPS, it is assumed that abandonment could include the following:

- All aboveground pipelines, valves, and supporting structures would be removed to a depth that would prevent frost heave action lifting the remnant to the surface.
- Any below-ground pipeline segments would be cleared, cleaned of oil and other residues, capped, and left in place in locations where they would not interfere with other abandonment activities or planned land uses.
- Central production facilities would be used as work camps and staging areas to support pipeline abandonment activities.
- Residual, surplus, and scrap materials would be reused or recycled to the extent possible, and waste materials would be disposed of in accordance with applicable regulations.

It is assumed that aboveground facilities would be removed and wells plugged and capped. Equipment could be retrofitted for other North Slope use, or removed from the North Slope for subsequent reuse or scrap. Just as with roads, the ultimate fate of the gravel pad would not be known until closer to end of the production pad life. Permitting agencies could require that gravel be removed, in part or total, and the tundra revegetated. If other uses are determined by the permitting agencies to be preferable, the agencies could allow the permittee to leave the gravel pads in place, either revegetated or not revegetated. Removed gravel either would be disposed of or reused for another development.

Abandonment of airstrips could occur in conjunction with abandonment of pads. The gravel airstrips would be managed in a similar manner, depending on the decisions made by land managers and permitting agencies at the time of abandonment. Gravel airstrips would either be removed and the tundra revegetated, revegetated but otherwise left in place, or left in place and maintained for public use.

As with roads, abandonment of bridges and culverts would occur once the economic life of the oil fields had passed. Because the bridges and culverts are an integral portion of the proposed road network, the fate of the bridges would likely be determined by the fate of the road network. If bridges were removed, bridge superstructures would be taken apart and transported out of the area for recycling or disposal of the materials. Bridge piles likely would be cut off below the lowest anticipated scouring elevation from either natural scouring or a flood-induced event. The area of bridge abutments would be revegetated in a manner similar to that of the roadbed after gravel removal. If roads were left in place, but not with the intention that they be maintained for continued use, culverts could be removed and the gravel pads breached to facilitate water flow.

Abandonment activities would occur during winter months, when ice roads could be constructed to allow the removal of equipment. Overall, abandonment operations would take many years, as revegetation and environmental monitoring studies would continue to document the long-term

effects of operations at a particular site. Monitoring abandonment would require periodic revisits to gather information on environmental parameters related to natural bedding and to document the success of abandonment actions. Normally, one helicopter with a crew of three would visit the sites annually for the first 5 years, followed by visits with increasing time gaps over the next 10 years. Site visits would include a maximum of 1 day per visit, and one visit per year. A series of permitting and inspection activities would be associated with any oil field abandonment, and would involve visiting the site as needed until satisfactory revegetation occurred.

Technical and Natural Constraints to Reclamation

The North Slope presents special technical challenges to restoration and recovery. Extremely cold temperatures, meager precipitation (5 to 7 inches per year), and the short growing season lengthen recovery times substantially beyond those possible elsewhere in the United States. Natural recovery of disturbed sites to original soil and plant conditions has been estimated to require 600 to 800 years for upland sites and 100 to 200 years for marsh sites (AOGA 2001).

Recovery of disturbed sites on the North Slope is complicated by the fact that any disturbance of the insulating vegetative mat can melt the underlying permafrost, a process that is extremely difficult to reverse and that can continue long after the initial disturbance ends. Finally, gravel pads and roads, which account for the vast majority of the directly affected habitat on the North Slope, retain moisture and nutrients poorly and thus slow recovery processes.

Recovery times in the Arctic, as elsewhere, depend in part on the nature and extent of disturbance and the type of habitat affected. For example, wet sites tend to recover quickly from light oil spills; dry sites affected by diesel fuel spills recover exceedingly slowly, with little recovery occurring after several decades (Walker 1996). Disturbed areas that would recover relatively quickly in more temperate climates (such as those caused by Caterpillar tractor tracks), can persist for many decades because of melted permafrost.

Reclamation Research

During the past few decades, considerable industry research has examined the feasibility of rehabilitating areas disturbed by oil field activities (McKendrick 1997). Until recently, work focused on revegetating sites with exotic grasses to avert erosion. More recent efforts have focused on the use of native grasses and forbs and on the restoration of habitat processes and aesthetics, all of which are much more challenging goals (AOGA 2001).

A variety of rehabilitation strategies has been developed, including flooding of gravel mine sites to create overwintering habitat for fish; creation of wetlands in ponds perched on overburden stockpiles; revegetation of thick gravel fill and overburden to compensate for lost wildlife habitat; removal of gravel fill to help restore wet tundra habitats; restoration of tundra on less severely modified habitat; and remediation of areas contaminated by oil spills, seawater spills, and drilling mud (Jorgenson and Joyce 1994). The oil industry is conducting experiments at several sites throughout the Prudhoe Bay oil field and at old well sites in the NPR-A. Preliminary results indicate that, if cost is not a factor, a productive and diverse vegetative cover can be established even on sites with severe ecological limitations. Most of the studies suggest that natural recolonization occurs relatively rapidly on thin fill and on organic rich fill where moisture and nutrients are not severely limiting (Jorgenson 1997). Low temperatures near the coast, however, reduce the number of species available and the rate at which recolonization occurs. A survey of 12 revegetated pads in the NPR-A showed that, on average,

only 3 native species were found on pads at the cold coastal sites, 10 were found on inland coastal plain pads, and 24 were found on relatively warm foothills sites (McKendrick 1987). Fertilization and seeding with normative species appears to delay natural recolonization (Jorgenson 1997).

More costly methods are required for rehabilitating the gravel roads, pads, and mine sites that dominate disturbed land. Construction of berms and basins, application of topsoil, and use of various plant cultivation techniques are required on these sites. However, only a very limited amount of topsoil has been stockpiled for future use in the oilfields (Jorgenson 1997). Sewage sludge is being considered as an alternative source of organic material. Native legumes with nitrogen-fixing ability could be essential for sustaining the long-term productivity of those sites.

Removal of gravel fill has recently been done in wetlands, and preliminary studies suggest that wetland mosaics of vegetation can be restored, if only partially, although the method is expensive and finding acceptable locations for the fill can be difficult (Kidd et al., 2004). Open-pit gravel mine rehabilitation typically involves converting mine sites to lakes, with a channel usually cut between the pit and a stream or river so the site can be accessible to fish. Such sites create potential overwintering habitat for fish, but they also result in the permanent loss of the original habitats.

4.7.5 Resource Protection Measures Considered in the Cumulative Effects Analysis

The cumulative impacts assessment assumes that ROPs and lease stipulations developed for the alternatives (see Table 2-2) would be adopted to protect environmental and social resources in the planning area. The effectiveness of these protections has been addressed under each resource area for each alternative in **sections 4.3 through 4.6**, and in Table 2-2.

In addition, a number of Federal, state, NSB, and Alaska Native resource management and monitoring programs have been established to protect environmental resources and, in cases where there is existing environmental impairment, to effect restoration. The assessment of cumulative impacts must recognize the existence of these programs and assume that the mandate under which each program was established will continue. The practical effect of these programs is that they are assumed to require avoidance or mitigation of the environmental impacts that they are designed to address. The programs assumed to continue for the cumulative impact assessment are the same as those listed in the Amended IAP/EIS and are described by the resource that they manage or protect in the following sections:

4.7.5.1 Air Quality

Air quality is regulated under the Federal Clean Air Act, as implemented by the State of Alaska, Department of Environmental Conservation, Division of Air Quality, with oversight by EPA Region 10. In addition, ADEC may establish regulations which are more (but not less) stringent than the Federal requirements. Under both the Clean Air Act and FLPMA, BLM may not conduct or authorize activities which do not comply with all applicable local, state, tribal, and Federal air quality laws, regulations, standards, and implementation plans. Climate activities focus on monitoring observed conditions and predicting potential changes due to global increases in greenhouse gasses. The State Climatologist is located at the Alaska State Climate Center on the University of Alaska campus in Fairbanks. Currently, there are no

regulations applicable to climate or climate change, although there is much discussion regarding potential limits of fossil carbon emissions.

4.7.5.2 Water Quality

Water quality on the North Slope is regulated and/or monitored through various permitting and regulatory programs administered by the USEPA, ADNR, ADEC, ADFG, and NSB. These programs have been established to protect against the significant degradation of water quality associated with specific human and development activities. In evaluating the cumulative effects to water quality, collective impacts associated with regulated and non-regulated activities and naturally occurring events are considered.

4.7.5.3 Wetlands and Floodplains

Wetland impacts are mitigated through Section 404 of the Clean Water Act, administered by the USACE. The objective of mitigation for unavoidable impacts is to offset environmental losses. Under a Memorandum of Agreement between the USEPA and USACE, it is recognized that in areas such as the North Slope of Alaska, avoidance or compensatory mitigation may not be practical due to the high proportion of land that is wetlands. The USEPA and USACE are working with industry to develop alternate methods to satisfy necessary compensation requirements for loss of wetlands on the North Slope.

4.7.5.4 Essential Fish Habitat

The amended Magnuson-Stevens Act requires Federal agencies that authorize, fund, or conduct activities that may harm Essential Fish Habitat to work with NOAA Fisheries Service to develop measures that minimize damage to EFH. By providing EFH conservation recommendations before an activity begins, NOAA Fisheries Service may help prevent habitat damage before it occurs, rather than restoring habitat after the fact, which is less efficient, unpredictable, and often more costly.

4.7.5.5 Caribou

The ADFG, NSB and BLM monitor caribou by population censuses; calving, composition and yearling survival surveys; and caribou movement and distribution studies. These monitoring efforts provide a means of determining whether cumulative effects on caribou have occurred, or are occurring, on the North Slope, and help in developing measures to minimize effects.

4.7.5.6 Marine Mammals

The management of seals by NOAA Fisheries Service and polar bears by the USFWS under the Marine Mammal Protection Act of 1972 provides for protecting these species' populations and mitigating the potential effects of development on these species. For example, the USFWS implements measures to protect polar bear den sites through a Letter of Authorization under the Marine Mammal Protection Act.

4.7.5.7 Threatened and Endangered Species

The potential effects from all Federal actions on listed species would be identified and potential mitigation offered by NOAA Fisheries Service and the USFWS as required by Section 7 of the ESA.

4.7.5.8 Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, and an accompanying Presidential memorandum require each Federal agency to make the consideration of environmental justice part of its mission. The existing demographics (race and income) and subsistence consumption of fish and game would be discussed, disproportionate environmental and health effects on Alaska Natives would be evaluated, and mitigating measures and their effects would be presented in any EIS considering Federal actions.

4.7.5.9 Consultation and Coordination with Indian Tribal Governments

Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, requires consultation with Native tribal governments on "actions that have substantial direct effects on one or more Indian tribes." Future Federal actions will also be subject to this procedure that would assure tribal concerns are heard.

4.7.6 Other Information Considered in Cumulative Effects Analysis

The assessment of cumulative impacts from oil and gas activities also considered the following information:

- More rigorous environmental standards and more environmentally prudent industry practices exist than ever before, including smaller facility footprints, fewer roads, directional drilling, elimination of most surface discharges into the water, practices that avoid damage to the tundra, and better working relations with the local residents.
- Current industry practices and the environmental state of the North Slope/Beaufort Sea region are continually observed and assessed, and much of this information is available to the public. This information, along with the ongoing dialogue between all levels of government and the interested public about environmental issues should continue to increase environmental awareness and encourage environmentally sound practices that, in turn, help reduce the potential for environmental damage.
- A key element in the development of North Slope/Beaufort Sea oil is the means of transporting the oil to outside markets–TAPS. The TAPS pipeline is 800 miles long, stretching from Pump Station 1 at Prudhoe Bay to the Valdez Marine Terminal. Assuming a corridor width of about 100 feet, it represents an area of about 16 square miles. This pipeline is expected to continue to serve as infrastructure for all oil production in the foreseeable future, eliminating the need for the construction of new oil pipelines other than feeder pipelines.
- Following the Exxon Valdez oil spill, substantive improvements have been made in tanker safety to reduce the potential for oil spills from tanker accidents, such as a mandatory phase-in of double-hulled tankers, better navigational systems, and tanker escorts. In addition, oil spill response capabilities for tanker-related oil spills have been increased substantially through the addition of equipment, personnel, training, and exercises. These initiatives were developed specifically to reduce the potential for future tanker accidents and to lessen their effects, should spills occur.
- If a large oil spill were to occur, such as occurred on the North Slope in March 2006, additional safeguards would likely be put in place and new ideas of pipeline placement and design would be researched. With these safeguards in place, the likelihood of an additional oil spill occurring from the same causative factors and impacting the same

resources would be reduced. This emphasis on preventing a similar incident would further ensure the full recovery of those resources from the initial spill.

- Actual activities and the size and location of future oil and gas developments on the North Slope and in the Beaufort and Chukchi Seas are uncertain; this Supplemental IAP/EIS presents a best estimate of what those activities and effects would be. It is unlikely that actual activities and effects would exactly match the scenarios developed for this IAP/EIS. Some past efforts to foresee future activities have over-stated the level of those activities in the projected scenario. Effective corrective measures have come out of ongoing monitoring by industry, government, and environmental groups. Subsequent discoveries and developments and other changes not accounted for in this scenario may need to be reassessed, as appropriate and as required by NEPA.

4.7.7 Cumulative Impacts

4.7.7.1 Air Quality and Climate

Cumulative air quality impacts may result from the emissions of fugitive dust (PM), byproducts of combustion (CO, NOx, and SO_2), and evaporation of hydrocarbons (VOC). These emissions are primarily associated with industrial and residential activity, and to a lesser extent with exploration activities, road and pad construction and use, and abandonment and reclamation. In addition to these criteria pollutants, certain hazardous air pollutants (HAP) may also be emitted, however an accurate determination of specific HAP quantities and potential impacts is not feasible at this stage, given that particular site-specific development activities and pollution controls are not yet able to be predicted. Air quality impacts would also result if a well blowout, or an oil spill occurs, especially if spilled oil is burned to mitigate the impacts of the spill. In addition to direct impacts to human health and welfare, indirect impacts include global climate change. Technology has played an important role in reducing air emissions from oil and gas facilities, and will continue in the future. These impacts may be regionally additive (e.g., increased concentrations from multiple facilities) or synergistic (e.g., photochemical reactions that form ozone).

4.7.7.1.1 Past and Present Effects and Their Accumulation

Ambient air quality on the North Slope of Alaska is generally good as a result of few pollution sources and good dispersion created by frequent winds, and neutral to unstable conditions in the lower atmosphere, even though oil and gas exploration, development, and production have been under way for more than 30 years. Historical emission sources consist mainly of diesel-fired generators in small villages, residential heating, snow machines, all-terrain vehicles, occasional small aircraft, limited local vehicle traffic, and occasional open burning. In addition, oil and gas related emissions originate in field production and drilling areas, such as gas–fired turbines and heaters, incinerators and flaring, diesel-fired power generators, storage tanks, fugitive hydrocarbon emissions, and mobile sources (vehicle traffic and aircraft). Regional sources of emissions consist of oil and gas production facilities east of the planning area, including Kuparuk, Milne Point, Prudhoe Bay, North Star, Endicott, and Alpine fields. Trace amounts of air pollutants, including metals, have been detected in vegetation at very low levels. Given its high latitude, the planning area is also subject to occasional "Arctic haze" resulting from elevated concentrations of fine particulate matter, primarily from emission sources in northern Europe and Asia (and to a lesser extent, northern Alaska.)

4.7.7.1.2 Future Effects and Their Accumulation

Emissions on the North Slope are expected to decrease as the result of an overall downward trend in oil production and advances in technologies which decrease emissions; therefore, air quality impacts from local sources is likely to be reduced. Greater reliance on technologies that reduce the need for permanent roads and pads, and reduce the size of the facility footprint, would specifically reduce PM emissions.

The types and relative amounts of air pollutants generated by oil and gas operations vary according to the phase of activity. During the exploration phase, emissions are produced by 1) diesel-fired equipment required for drilling exploratory and delineation wells; 2) vehicles used in support of drilling activities; and 3) intermittent operations such as mud degassing and well

testing. Air pollutant emissions from combustion processes consist primarily of NOx, CO, and SO_2, with lesser amounts of PM.

During the development phase, the primary emission sources are 1) internal combustion engines or turbines used to provide power for drilling, 2) heavy construction equipment used to install modules and pipelines, and 3) various vehicles and aircraft. The principal development-phase emissions consist of NOx, with lesser amounts of CO, PM, and SO_2.

During the production phase, the primary source of emissions is power generation for heating, oil pumping, and water injection. The emissions consist primarily of NOx, with smaller amounts of CO and PM. Another source of air pollutant emissions is evaporative losses of VOC from oil/water separators, pump and compressor seals, valves, and storage tanks. Venting and flaring also contribute to VOC and SO_2 emissions.

In addition to these criteria pollutants, certain hazardous air pollutants (HAP) may also be emitted. Benzene, toluene, ethylbenzene and xylenes are common HAP associated with volatilization of oil and gas resources, as is formaldehyde from compressor engines. Depending on conditions, hydrogen sulfide may also be found in oil, however an accurate determination of specific HAP quantities and potential impacts is not feasible at this stage, given that particular site-specific development activities and pollution controls are not yet able to be predicted.

Abandonment and rehabilitation activities would have impacts similar to those of construction since similar equipment and vehicles would be used. Because abandonment would occur at single locations for a short length of time, air quality impacts would be minor and short term. Impacts could be less than those associated with construction if gravel fill was left in place, due to less use of vehicles and machinery. Particulate matter emissions would also be reduced at sites that are re-vegetated.

Potential impacts from future oil and gas activities would be scattered over a large regional area. Emissions associated with routine program activities would increase, although all applicable standards would continue to be met. Maximum concentrations of air pollutants will occur close to facility boundaries, and dissipate rapidly as distance from the facility increases. Thus, it is unlikely cumulative interaction between developments would occur.

However, until air pollution emissions in Asia and Europe decline, Arctic haze is likely to persist or get worse.

4.7.7.1.3 Global Climate Change

The assessment of so-called "greenhouse gas" emissions and climate change is in its formative phase, and it is not yet possible to know with confidence the net impact to climate. However, the Intergovernmental Panel on Climate Change (IPCC, 2007) recently concluded that "Warming of the climate system is unequivocal" and "Most of the observed increase in globally average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic [man-made] greenhouse gas concentrations."

However, potential impacts to air quality due to climate change are likely to be varied. For example, if global climate change results in a warmer and drier climate, increased particulate matter impacts would occur due to increased wind blown dust from drier and less stable soils. Alternatively, reclamation efforts may be more successful with more favorable conditions for

plant growth. Warmer temperatures are also likely to reduce emissions from combustion sources used for residential heating, and may enhance dispersion of air pollutants.

4.7.7.1.4 Contribution of the Supplemental Alternatives to Cumulative Effects

Although potential increases in air pollutant emissions would occur under any of the Alternative scenarios analyzed, given the dispersed nature of satellite well pad and central production facilities from each other and from residential communities, resulting cumulative air quality impacts on the North Slope are not likely to be significant.

Of the four Alternatives, Alternative A (No Action) would emit these least amount of air pollutants. Air pollutant emissions associated with Alternative B would represent a 17 to 19 percent increase, Alternative C emissions would be 38 to 40% higher, and Alternative D emissions would be approximately 23 to 26% greater than Alternative A emissions.

If oil and gas development is allowed North of Teshekpuk Lake as contemplated in Alternatives B through D, overall air quality and climate impacts in Northwest NPR-A and the Beaufort Sea would not change significantly. However, if the availability of infrastructure and facilities within the adjoining sections of the planning area were to facilitate additional oil and gas activities, air pollutant emissions from those areas are likely to increase. It is also possible that the timing of impacts could occur sooner due to improved access. In addition, site-specific NEPA analyses would be required to demonstrate both direct and cumulative (regional) air quality impacts would comply with applicable local, state and Federal air quality requirements.

4.7.7.1.5 Conclusion

For the North Slope area as a whole, air quality should improve in those areas where oil production currently is the greatest, and would decline somewhat in areas where future development is expected to occur. It is likely that new development would be distributed throughout the planning area, keeping regional impacts small, except for localized concentrations in the immediate vicinity of production facilities.

The cumulative effects of all activities affecting the North Slope of Alaska in the past have caused minor deterioration in air quality, well within legal limits. Improvements in air pollution control technology would help to reduce emissions from historic levels, as would emission reductions due to overall declining production on the North Slope. Regional air pollutant emissions generated would remain near current levels; approximately 30% less than emission levels in the late 1980s. Each proposed individual facility will be required to disclose its potential air quality impacts thorough site-specific NEPA analyses, and demonstrate its continued compliance with applicable local, state and Federal air quality requirements. As facilities are shut down, they would no longer contribute to North Slope air emissions. Particulate matter emissions would also be reduced at sites that are reclaimed.

4.7.7.2 Paleontological Resources

Paleontological resources (plant and animal fossils) are nonrenewable. Once they are impacted or displaced from their natural context, the damage is irreparable and cumulative. While much of the planning area and North Slope is underlain by paleontological resources, most of these resources are of the marine plant and invertebrate variety and are so numerous that the potential impacts addressed in this supplement do not present a substantial threat. However, vertebrate fossils are much less common and are more likely to be impacted by the activities

associated with non-oil and gas activities and oil and gas exploration and development on the North Slope.

While oil and gas exploration and development are the primary contributing activities in terms of cumulative effects on paleontological resources on the North Slope, other contributing factors may also be important. These factors include permitted activities such as non-oil and gas development, overland moves, scientific data gathering, and recreation, and global climate change.

4.7.7.2.1 Past and Present Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Non-oil and gas activities, including camps associated with scientific studies, recreational use, overland moves by transport vehicles, and use of OHVs such as four-wheel vehicles and snowmachines, have likely impacted near-surface paleontological resources. Where Caterpillar or similar tractors have been used, or the vegetation has been bladed, vegetation scars persist to this day. An estimated 250 acres of tractor trail/tundra scars were created before 1973; about 50 acres remain evident today (NRC 2003).

Paleontological research and excavation, necessary for the recovery of scientific data, have contributed minimally to the displacement of paleontological resources. Recreational activities and past exploration of the North Slope led to legal and illegal collecting and inadvertent damage, especially prior to the 1970s when there was less concern for protecting these resources. Most paleontological material is buried considerably deeper than archaeological material and is therefore not regularly encountered by chance. Some Pleistocene-age animal remains could be recovered in archaeological deposits if the deposit were old enough. Construction of DEW-Line and other military sites, and village-related development on the North Slope, have also likely contributed to the loss of paleontological resources, either from removal or destruction. Approximately 2,500 acres have been impacted by these developments.

Oil and Gas Exploration and Development Activities

Ground-disturbing activities associated with oil and gas exploration and development have likely impacted paleontological resources. The older, land-based 2-D seismic technology consisted of long, intersecting seismic lines that used either dynamite or vibrators as the energy source. In the early stages of seismic data acquisition on the North Slope, much less care was taken to minimize damage to the tundra during data acquisition. Damage, then as now, can result from inadequate snow cover and inappropriate equipment. Early roads were bladed in the tundra, and over 500 acres of roads were constructed by mounding peat (NRC 2003). Thus, near-surface paleontological material could have been lost. Use of ice roads and improvements in seismic gathering techniques (3-D technologies and use of low-ground-pressure vehicles) have resulted in fewer impacts to the ground surface, and potentially to paleontological resources, than occurred in the past.

The excavation of gravel to construct roads, pads, and other facilities since the late 1960s has added to the loss of paleontological resources. Most mammalian fossils are of Quaternary age, which also is the age and origin of most North Slope gravel sources. Therefore, the more gravel deposits that are excavated for development activities, the greater possibility that impacts to paleontological resources would occur. Through 2001, over 6,300 acres have been disturbed for

gravel mines on the North Slope, with over 5,000 acres of disturbance occurring along rivers where paleontological resources are often exposed or close to the surface.

During the past several decades, greater reliance on technologies that reduce the need for gravel to construct permanent roads and pads and reductions in the size of the facility footprint, and a slowing of oil development activities, have substantially reduced the amount of area disturbed annually to extract gravel resources. In addition, state and Federal regulations that require surveys for and prohibit the removal of paleontological resources have also slowed the cumulative loss of paleontological resources.

Summary of Past and Present Impacts and Their Accumulation

Paleontological research and excavation, non-oil and gas development, recreation, and oil and gas exploration and development have contributed to the loss of paleontological resources on the North Slope, either from removal or destruction. If paleontological resources removed in the past have been preserved in museum or private collections, their losses would not accumulate. If they have been lost forever, the impacts of this lost resource persist today. Approximately 2,500 acres have been disturbed or covered with gravel for non-oil and gas development. Approximately 1,750 acres have been disturbed from bladed and peat roads, exploration sites, and airstrips. Gravel mining has disturbed over 6,300 acres, much of this area along rivers where paleontological resources are often exposed or are close to the surface. Another 9,200 acres have been covered with gravel to create pads and roads. Paleontological resources in these areas could be damaged, destroyed, or buried under gravel. Recent technological developments, including use of ice roads and pads, Rolligons, horizontal drilling, and development that does not require a gravel road linkage to the Prudhoe Bay-Kuparuk infrastructure have reduced the amount of surface disturbance associated with exploration and development activities, with likely benefits to near-surface paleontological resources.

4.7.7.2.2 Future Effects and Their Accumulation

Vertebrate paleontological resources are distributed unevenly across the North Slope and deposits are often unknown until some sort of disturbance occurs, making it difficult to assess potential cumulative impacts to the resource. The more oil and gas associated activities that occur, the larger the area affected and the greater the possibility that vertebrate paleontological resources would be impacted. Non-Quaternary age paleontological material is usually deeply buried and therefore protected from most oil and gas related activities. From the standpoint of vulnerability in most settings, paleontological resources, especially non-Quaternary materials, are well protected by nature. In other instances, particularly with Quaternary fossils, they are located on or near the ground surface and are very susceptible to impacts. In most cases, surface or near-surface paleontological resources are more likely to be impacted as the result of exploration activities than by development, since most exploration-related operations occur in the low-light conditions of winter. Although snow cover may offer some protection, it also disguises surface manifestations, making them difficult to recognize and avoid.

Increased oil and gas development activities on the North Slope would result in an increased need for gravel for infrastructure construction. The excavation of up to 2,200 acres of gravel by the end of this century for well pads, roads, and airstrips could impact cultural resources. Many Quaternary age paleontological deposits are located in gravel deposits, which are not common in the northern portion of the NPR-A. As a result, a gravel deposit in the region will be highly valued and may be associated with paleontological remains. Therefore, the more gravel deposits

excavated for the construction of permanent facilities associated with development, the higher chance that impacts to paleontological resources would occur.

New innovations in technology that reduce the amount of surface disturbance associated with oil and gas activities and a slowing of oil and gas development on the North Slope, would contribute the future protection of paleontological resources and slow their cumulative loss. Assessments to identify and protect cultural resources also identify paleontological resources and therefore should minimize or avoid the loss of these resources. However, if a pipeline to take gas to market is constructed, burial of such a pipeline and of any pipelines that would bring gas to the northern terminus of the gas pipeline would inevitably result in risks of loss or at least disturbance of paleontological resources.

Effects of Natural Events

Most paleontological material is exposed as a result of natural erosion. Typically, erosion occurs as a result of the action of flowing water, but also can occur as a result of wind, seasonal freezing and thawing, ground subsidence due to the thawing of unstable permafrost, and the movement of soil down slopes as it thaws. Natural erosion, and its impact on paleontological resources, is difficult to assess because in most cases it is regarded as positive as it facilitates discovery rather than as a negative impact to the resource. Some of the most important paleontological resources are associated with river bank cuts and drainages.

Effects of a Large Oil Spill

The effects of a large oil spill on a paleontological deposit would be directly related to the time of year and the setting of the resource. If the spill were to occur during the time of year when the ground is not frozen, then the potential level of impact would be substantially higher. In an unfrozen setting, surface or near-surface paleontological resources would be impacted primarily from contamination that would affect radiocarbon and biomolecular analysis of the fossil material. Contamination would occur as a result of the cleanup rather than the actual spill. Impacts from both the spill and spill cleanup would be considerably less when the ground was frozen, although warm oil could melt the snow and permafrost and damage underlying paleontological resources. In the case of deeply buried paleontological deposits, neither the spill nor the subsequent cleanup (regardless of the time of year) would impact the resource.

4.7.7.2.3 Global Climate Change

Climate change could cause changes to the environment and habitats of the North Slope that could affect vertebrate paleontological resources (ACIA 2004). Climate change could result in changes to vegetation coverage and type and the physical structure of the landscape itself (ACIA 2004). The thawing of permanently frozen ground could result in the erosion of river banks and beach bluffs, which would result in impacts to known and undocumented vertebrate paleontological deposits. In addition, the thawing of permanently frozen ground could result in decreased preservation of subsurface materials particularly in areas with little or no organic soil and sparse vegetation. The action of flowing water, seasonal freezing and thawing (cryoturbation), thermokarsting, pingo and patterned earth formation, and solifluction can reveal paleontological deposits, but can also cause impacts as well. Climate change will also cause the alteration of weather patterns and an increase in the frequency and intensity of spring and fall storms is likely to occur adversely effecting near-shore paleontological deposits.

4.7.7.2.4 Contribution of Supplement Alternatives to Cumulative Effects

The greatest potential for cumulative effects would occur under Alternative C, as the greatest portion of the planning area would be available for leasing, and the amount of development proposed under the alternative is greater than for the other alternatives. The potential for cumulative effects under Alternative B would be about 20% less than C while Alternative D would be about 10% less than C. Much of the northeastern portion of the planning area would be closed to leasing under Alternative B. Teshekpuk Lake would be deferred from leasing under Alternative D, but the likelihood of any vertebrate paleontological resources being found in the lake would be small. However, RSO restrictions on permanent facilities in caribou habitat protection areas and the Goose Molting Area would limit the amount of surface disturbance that could occur north and east of Teshekpuk Lake; these restrictions would reduce the likelihood of cumulative effects to vertebrate paleontological resources within the planning area. Under Alternative A, about 600,000 acres in the Teshekpuk Lake Special Area would be closed to leasing.

Also to be considered is the potential contribution to regional cumulative impacts generated by the Northeast NPR-A Alternatives that could increase the possibility of adverse affects on vertebrate paleontological resources in the northeastern portion of Northwest NPR-A. Because Alternative A does not allow oil and gas infrastructure north of Teshekpuk Lake, an area believed to be of high oil and gas potential, it would probably serve to reduce/slow development in adjacent Northwest NPR-A in comparison with the other Northeast NPR-A Alternatives. Alternative C has the greatest potential for increasing cumulative impacts on cultural resources in northeastern Northwest NPR-A followed by Alternatives D and B.

Lease stipulations and ROPs developed for the 1998 Northeast IAP/EIS ROD and this supplement would reduce the likelihood of oil and gas exploration and development activities impacting paleontological resources. These include actions that require operators use low-ground-pressure vehicles and cease operations when the spring melt of snow begins; require setbacks along rivers, streams, lakes, cabins and the coast, providing additional protection for paleontological resources and through an orientation program for personnel that would include instruction on the importance of not disturbing paleontological resources; and require surveys prior to any ground disturbing activity. If paleontological resources are identified during surveys, BLM guidelines and policy require that all potential effects to the resources be mitigated to the satisfaction of the land manager.

4.7.7.2.5 Conclusion

Ground-disturbing activities, including non-oil and gas development and oil and gas exploration and development, have impacted paleontological resources to some degree. However, because of their unpredictable location, isolated and rare occurrence, and varying depth of deposit, the level of past and future impacts is difficult to assess. If lease stipulations were to continue to apply to survey and inventory prior to exploration and development activities, the cumulative impact to paleontological resources would be expected to be minor in the planning area; similar state and Federal regulations would help to limit impact to these resources elsewhere on the North Slope. Paleontological resources are nonrenewable, and once displacement or contamination impacts them, their value may be greatly and irreversibly compromised. Cumulative impacts to paleontological resources across the North Slope and in the planning area in the future are expected to be minor, given the small amount of area impacted and implementation of measures to avoid river drainages and other areas with known or likely paleontological resources.

In the case being considered here, Alternative A would contribute the least toward cumulative impacts with the potential to directly and indirectly generate adverse affects on on-shore paleontological resources on the North Slope. Alternatives B, C and D have a greater potential for creating cumulative impacts because all of those Alternatives allow more area of high oil and gas probability to be leased (submerged off-shore paleontological resources, if present, would generally not be threatened by off-shore oil and gas exploration/development activities).

4.7.7.3 Soil Resources

4.7.7.3.1 Past and Present Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Non-oil and gas activities, including archaeological and paleontological digs, camps associated with scientific studies, recreational use, overland moves by transport vehicles, and use of off-highway vehicles such as four-wheel vehicles and snowmachines, have likely caused soil loss and erosion on less than 100 acres in the planning area. In most cases, loss of soil and erosion would be temporary, lasting only a few years. Where Caterpillar or similar tractors have been used, or the vegetation has been bladed, scars in the soil persist to this day. An estimated 250 acres of tractor trail/tundra scars were created before 1973; about 50 acres remain evident today (NRC 2003).

DEW-Line sites and other military facilities, villages, public roads, airstrips, and other non-oil and gas infrastructure have been developed using gravel pads or on bare ground. Approximately 2,500 acres have been impacted (about 700 acres for DEW-Line sites and related development, and 1,800 acres for villages), and this loss of soil and soil productivity are likely to persist into the indefinite future.

Oil and Gas Exploration and Development Activities

Seismic Activities and Exploration. Much of the ACP has been surveyed since 1940, and soil was disturbed to varying degrees depending upon the soil and vegetation type, vehicle type, operator vigilance, and amount of snow cover. Studies of seismic and camp-move trails created in the 1980s showed that only a small portion of seismic trails were still evident 8 years later, yet 5% of camp-move trails still showed moderate to high disturbance. The greatest damage occurred where the vegetative mat was destroyed and the underlying soil was exposed. This resulted from tracked vehicles or sleds on skids cutting into hummocks, or from Caterpillar operators making a tight turn and dropping the blade too deeply into the snow. About 50 acres of tractor trail/tundra scars persist today.

Use of newer technologies, including use of vehicles that apply less pressure to the ground and restricting travel to periods when there is frozen ground and adequate snow to protect vegetation, have reduced the level of impacts to soil. In 2001, a study conducted the summer following seismic work, found little to no impacts to tundra under seismic lines on 30% of the plots studied (Jorgenson et al. 2003). Minor impacts were found on 66% and moderate impacts were found on 4% of the plots; no plots were highly impacted. Camp move trails in this study had little or no impacts on 18%, minor impacts on 54%, moderate impacts on 29%, and high impacts on none of the plots. Impacts to soil were minor in areas with good tundra cover. This

study suggested that improvements in the equipment and procedures used for seismic surveys have reduced the amount of impact to tundra and soil.

Other sources of soil loss include exploration sites with gravel pads, disturbed areas around these pads, exploration airstrips, and gravel exploration roads. Based on Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope (NRC 2003), in 2001, approximately 1,700 acres had been impacted by these sites in the past, and 1,130 acres of disturbance were still evident. Most of these sites were developed before 1977, thus their effects on the landscape have persisted for decades, and are likely to persist for several more. However, exploration activities are now limited to the use of ice roads and ice pads that greatly reduce long-term impacts to soils from these activities compared to gravel roads and pads.

Oil and Gas Infrastructure. Peat and gravel roads and pads, and gravel mines have caused the direct loss of soil, and also led to the indirect loss of soil from thermokarst and alteration of natural drainage patterns. Through 2001, over 500 acres of peat roads still showed evidence of disturbance, even though most of these roads were constructed over 30 years ago. Gravel has been used to construct approximately 9,000 acres of roads and pads, while gravel mines have impacted approximately 6,000 acres. Other impacted areas cover approximately 2,000 acres (NRC 2003, p.44). The total area impacted on the North Slope from this infrastructure adds up to approximately 17,500 (500 + 9,000 + 6,000 + 2,000) acres. Of this amount, approximately 4,500 acres of gravel mines have been reclaimed, but only 70 acres of pads and roads (NRC 2003). Even though the lakes left behind by former gravel mines are considered reclaimed due to their value as aquatic habitat, the loss of soil resources is permanent. Thus, impacts to soil and soil productivity persist on approximately 17,500 acres.

Construction of gravel pads, roads, and airstrips has altered the moisture regime of tundra near the structure by changing natural drainage patterns and areas where snow accumulates. Snowdrifts caused by gravel structures have increased the wintertime soil surface temperature and increased thaw depth in soils near the structures. These impacts have been exacerbated by dust deposition and by the formation of impoundments. These factors combine to warm the soil, deepen thaw, and cause thermokarst adjacent to roads and other gravel structures (NRC 2003). In flat, thaw-lake plains on the North Slope, one study published in 1987 found that past gravel construction resulted in upslope water impoundment and thermokarst erosion equivalent to twice the area directly covered by gravel (Walker et. al. 1987). However, cumulative impacts recently reported by the National Research Council found that the ratio of direct to indirect impacts from gravel structures such as roads was about one to one (NRC 2003, p 95). If so, the condition of an additional 17,500 acres of soil may have been altered due to hydrologic changes on the North Slope. Based on this information, the total of direct and indirect long term impacts to soils from past and present oil and gas activities on the North Slope covers approximately 35,000 (17,500 direct + 17,500 indirect) acres.

Recent technologies, including development not dependent upon a gravel road connection to the Prudhoe Bay-Kuparuk infrastructure, horizontal drilling, closer spacing of wells on pads, and a slowing of oil field development, have greatly reduced the amount of surface disturbance needed to develop and produce oil. As a result, the annual amount of surface disturbance associated with gravel roads and pads has slowed substantially during the past two decades.

Spills. Overall, the effects of spills on soil have not accumulated on the North Slope because all but two of the spills have been small and cleanup and rehabilitation efforts have generally been successful (NRC 2003). The largest spill in the North Slope oilfields (over 200,000 gallons)

occurred in March of 2006; it is likely that some soil was damaged during the clean-up and remediation efforts, which are still ongoing.

Summary of Past and Present Effects and Their Accumulation

Based on the above analysis, approximately 2,500 acres of direct impacts to soil from non-oil and gas activities persist today. Oil and gas activities have caused approximately 17,500 acres of direct impacts to soil that persist today; another 17,500 acres of indirect impacts have also occurred, some of which persist today. Therefore, a total of approximately 37,500 (2,500 + 17,500 + 17,500) acres of soil resources on the North Slope still show impacts from all past activities. Since most of these impacts are associated with ongoing non-oil and gas residential and commercial development, and oil and gas activities, these impacts to soil are additive to future impacts and would be likely to persist for several decades or more. However, the rate at which soil is disturbed by development has slowed substantially in recent years due to advances in technology and a slowing of oil field development on the North Slope.

4.7.7.3.2 Future Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

It is anticipated that villages will continue to expand in the future due to population growth and to provide services and infrastructure to support new oil and gas development on the North Slope. The amount of area that would be disturbed by new development is projected to increase by 2% annually for the next 40 years or so and then level off (see **section 4.7.2.1**). Assuming community infrastructure and footprint grow at roughly the same pace as population, there would be approximately 3,600 acres of community footprint by the time population may level off in the 2040s.

Oil and Gas Exploration and Development Activities

Seismic Activities and Exploration. Based on past seismic activity on the North Slope, BLM assumes continuation of the recent experience of three to four seismic crews active there each winter and that the miles of 2-D and 3-D surveys, the associated camp-move miles, and the proportion of 2-D and 3-D surveys anticipated in Northeast NPR-A will over time approximate the average throughout the North Slope. Based on these assumptions, approximately 86,400 acres would be covered annually by seismic activities, including camp moves, on the North Slope. Soil and vegetation recovery studies have shown that most impacts to soil from seismic activities and exploration should be minor and short term (NRC 2003). However, approximately 125 acres of that yearly total may still show moderate to high levels of disturbance a decade later.

Oil and Gas Development and Production. Future development and production could occur on the North Slope in Northeast NPR-A, Northwest NPR-A, the Chukchi Sea Planning Area, onshore between NPR-A and ANWR, and in the Beaufort Sea (see 4.7.3.3). New development, especially for economically marginal fields of oil, would most likely occur near existing fields so that infrastructure systems could be shared. Additional long-term impacts to soil resources would occur as a result of this development.

Oil and gas development and operation would affect soils by compacting and damaging soils under gravel pads, gravel roads, and gravel airstrips; excavating material sites; constructing VSMs for elevated pipelines; and excavating trenches for buried pipelines. These impacts would

be long-term. Construction of gravel pads, roads, and airstrips could also result in indirect effects to soils by altering the moisture regime of tundra near the structure due to changing natural drainage patterns and areas where snow accumulates. Snowdrifts caused by gravel structures would increase the wintertime soil surface temperature and increase thaw depth in the soil near the structures. These impacts would be exacerbated by dust deposition and by the formation of impoundments. These factors could combine to warm the soil, deepen thaw, and cause thermokarst adjacent to roads and other gravel structures. This can result in approximately one acre of indirect impacts to soil for each acre of direct impact (NRC 2003, p 95).

Offshore development associated with leases in the Beaufort Sea could impact small areas along the coast for staging and storage of materials, but is unlikely to impact large areas of soil. Similarly, development in the Chukchi Sea could require a pipeline across Northwest and Northeast NPR-A. However, long-term impacts to soils from elevated pipelines are mainly associated with VSMs that create only small areas of soil disturbance. For example, in Northeast NPR-A it is estimated that approximately 400 miles of elevated pipeline would create only 2 acres of long-term, direct surface disturbance from VSMs (Table 4.2-G). Additional areas of soil would be impacted if some buried pipelines were required.

Additional development and production could also occur east of Northeast NPR-A between NPR-A and ANWR. This analysis assumes that approximately 88% of the estimated undiscovered oil in the area would be brought into production in the foreseeable future (see 4.7.3.3). No estimates are currently available for the amount of additional infrastructure needed to produce this oil or gas, if a gas pipeline is constructed to deliver North Slope gas to markets. However, production would likely use a combination of existing infrastructure and new infrastructure resembling the Alpine field. Although the footprint would be relatively small compared with the total area, some additional areas of long-term disturbance to soils would be required for gravel staging areas, gravel roads, gravel pads, and other semi-permanent infrastructure.

Under Alternative C, which opens the entire planning area to oil and gas development in the Northeast NPR-A Supplemental EIS, long-term direct impacts to soil resources could occur on approximately 3,850 acres (excluding material sites, Table 4.2-G). Approximately 3,500 acres of soil could be directly impacted by gravel footprint if future development occurs in the Northwest NPR-A (see **section 4.7.3.3**). In addition, approximately 42 acres per year of gravel footprint can be attributable to all other North Slope oil and gas development for a total in these other areas of approximately 3,850 acres (see **section 4.7.3.3**). Therefore, the total area of soil resources on the North Slope directly impacted by future gravel footprint is estimated at 11,200 (3,850 + 3,500 + 3,850) acres (see **section 4.7.3.2**). Assuming a one to one ratio for direct to indirect impacts, a total of approximately 22,400 (11,200 + 11,200) acres of soil could be impacted long term by gravel footprint from future oil and gas development on the North Slope.

Excavation of material sites to supply the gravel would also impact soil resources on the North Slope. Assuming a ratio of one acre of gravel pit for every five acres of constructed gravel footprint, approximately 2,200 (11,200/5) acres of soil would be removed at material sites.

Trenching to bury gas pipelines, both one from the North Slope to Outside gas markets, and pipelines on the North Slope to bring gas to the beginning of that market pipeline, would alter the soil profile for all the area excavated. Based on estimates of disturbance associated with burying pipeline in the planning area and extrapolating that very roughly to other areas, it is estimated that approximately 500 acres of soil would be disturbed by being excavated to bury gas pipelines on the North Slope. An additional area would be disturbed by equipment and

temporary overburden storage in the course of burying the pipelines. Assuming a one to one ratio of direct to indirect impacts from buried pipelines, a total of 1,000 (500 + 500) acres could be impacted by construction of future gas pipelines on the North Slope.

The total future direct and indirect impacts to soil resources from future oil and gas development on the North Slope would be the sum of impacts from the gravel footprint, excavation of material sites, and construction of elevated and buried pipelines described above. Therefore, the total area of long term impacts to soils from future development would be approximately 26,000 (22,400 gravel footprint + 2,200 material sites + 1,000 pipelines) acres. These impacts are additive to the impacts to soil on approximately 35,000 acres that have accumulated from past and present oil and gas activities that persist today (see Summary of Past and Present Effects and Their Accumulation above).

Oil Spills. The projected increase in activity levels combined with the potential problem of aging pipelines could result in more spills. However, the recent large spill in March 2006 caused by pipeline corrosion may lead to better overall maintenance, oversight, and prevention of potential problems that can lead to spills. Overall, the effects of spills on soil have not accumulated on the North Slope because the spills have generally been small and cleanup and rehabilitation efforts have generally been successful (NRC 2003).

Abandonment. As more oil and gas development and production occur on the North Slope, the more need there will eventually be for abandonment of infrastructure and rehabilitation of soil resources. Removal of aboveground facilities, pipelines, bridges, and power poles would have a minor impact on soils and permafrost. Soils and permafrost would remain unaffected for as long as gravel structures such as pads and roads were maintained. Once maintenance of the roads and pads ceased, thaw subsidence in ice-rich areas could result in settling of the gravel structures into thermokarst troughs. Removal of the roads and pads would accelerate thaw subsidence, but would also accelerate the reclamation process.

The North Slope presents special technical challenges to restoration and recovery. Extremely cold temperatures, meager precipitation (5 to 7 inches per year), and the short growing season lengthen recovery times substantially beyond those possible elsewhere in the United States. Natural recovery of disturbed sites to original soil and plant conditions has been estimated to require 600 to 800 years for upland sites and 100 to 200 years for marsh sites (AOGA 2001).

4.7.7.3.3 Global Climate Change

Permafrost. The primary effect to soil resources that could occur as a result of a warming climate in the arctic is thawing of the permafrost. The entire planning region is underlain by cold, deep permafrost that varies from 660 to 2,130 feet on the North Slope (NRC 2003). Near-surface temperatures of this permafrost have been slowly rising and temperatures now range from -10 °C to -6 °C. A study of permafrost temperature measured in boreholes showed an increase of 2 to 4 Celsius degrees over a period from a few decades to a century (Lachenbruch and Marshall 1986). If this warming continues, the depth of the active layer is likely to increase. As the climate warms, the permafrost will thaw to an increased depth each season which will cause varying degrees of impacts on subsidence, soil moisture, and vegetation. However, because of the great depth of the permafrost on the North Slope it would take several decades of warming at the predicted rate before it would transition into discontinuous permafrost (NRC 2003, p.59).

Since oil and gas activities can also cause local thawing of permafrost, the effects of a warming climate would add to the thawing effects of direct and indirect impacts from oil and gas development activities on the North Slope. These cumulative effects would occur locally in areas of surface disturbance described earlier. If the climate continues to warm, the period in which there would be adequate snow and frost on the ground to support seismic and other exploration and development activities would decrease, and the potential for these activities to disturb the soil would increase. The effects of changing climate on permafrost are difficult to predict, and predicting how oil and gas development effects to permafrost might accumulate is more uncertain than predicting climate change (NRC 2003, p.59). However, if the permafrost continues to warm, its ability to support structures would diminish, which could affect development on the North Slope. Thicker gravel may be needed to support structures, and abandoned work pads and roads could become unusable as they are cut up by deep polygonal troughs over thawing ice wedges, or by other thermokarst degradation.

The potential for many shallow streams, ponds, and wetlands in the Arctic to dry out under a warming climate is increased by the loss of permafrost (ACIA 2004). However, as noted above, it would take many decades at the predicted rate of warming for permafrost in the North Slope to become discontinuous and create this effect. In other areas, warming of the surface permafrost could increase the formation of ponds, wetlands, and drainage networks, especially in areas with heavy concentrations of ground ice. Such thawing could lead to increases in soil erosion and sediment being deposited in rivers, lakes, and coastal marine environments. Another potential effect to soil resources from climate warming is an increased rate of decay of organic matter in the soil. Experimental studies have shown that a warming of the soil could lead to increased turnover of soil organic matter and redistribution of nitrogen from soils to vegetation (Nadelhoffer et al. 1992 in NRC 2003). If warming were accompanied by decreased soil moisture, there could be a long-term loss of both carbon and nitrogen from the system, and potential losses of mineralized nitrogen from leaching. Many of these potential effects from a warming climate to soils could make it more difficult to prevent degradation of, or rehabilitate, areas disturbed by oil and gas activities on the North Slope.

Coastal Erosion. Another adverse effect to soil resources and permafrost as a result of climate warming is increased erosion along coastal boundaries. Rising temperatures are altering the Arctic coastline and changes are projected to continue during this century as a result of reduced sea ice, increased impacts from ocean waves, thawing permafrost, and sea-level rise (ACIA 2004). Thinner, less extensive sea ice creates more open water, allowing stronger wave generation by winds and increasing wave-induced erosion along Arctic shores.

Increased wave activity and storm surge combined with seal level rise would inundate marshes and coastal plains, accelerate beach erosion, and force salt water into bays, rivers, and groundwater. Coastal regions with underlying permafrost are especially vulnerable to erosion as ice beneath the seabed and shoreline thaws from contact with warmer air and water. The projected increase in air and water temperature, reduction in sea ice, and increase in height and frequency of storm surges are expected to have a destabilizing effect on coastal permafrost, resulting in increased erosion. Since oil and gas activities can also cause local thawing of permafrost, the effects of a warming climate would add to the thawing effects of direct and indirect impacts from oil and gas development activities along coastal boundaries. These cumulative effects could occur locally in areas of surface disturbance near coastal boundaries.

4.7.7.3.4 Contribution of Supplement Alternatives to Cumulative Effects

Depending on the alternative selected in the Northeast NPR-A Supplemental EIS, long-term direct and indirect impacts to soil resources could occur on 6,000; 6,800; 8,500; or 8,100 acres under Alternatives A, B, C, or D respectively. The alternative selected could also affect the development of oil and gas in other areas outside the planning area. This development in turn could impact soil resources inside, and in areas adjacent to, Northeast NPR-A.

As noted above, new development, especially for economically marginal fields of oil and gas, would most likely occur near existing fields so that infrastructure systems could be shared. Alternatives B, C, and D would open the northwest portion of the planning area to leasing. Infrastructure such as pipelines and CPFs developed in this area would make marginal discoveries in the adjacent northeast portion of Northwest NPR-A more likely to be developed in the foreseeable future. Therefore, impacts to soil resources from oil and gas development in the northeast portion of Northwest NPR-A would be more likely to occur in the foreseeable future under Alternatives B, C, and D. However, if infrastructure for adjacent areas is planned concurrently, a reduction in the total footprint could occur compared to planning for development separately. Under Alternative A, development of marginal fields in the northeast portion of Northwest NPR-A, and resulting impacts to soil resources, would be less likely to occur.

Existing pipelines and infrastructure as a result of Alternatives B, C, or D could also make it more feasible to develop offshore leases in the Beaufort Sea north of Teshekpuk Lake. This may require additional pipelines to connect to existing pipelines in the planning area. However, long-term impacts to soils from elevated pipelines are mainly associated with VSMs that create only small areas of soil disturbance. Additional areas of soil would be impacted if some buried pipelines were required.

4.7.7.3.5 Conclusion

Cumulative impacts to soils on the North Slope would occur from activities associated with non oil and gas development and oil and gas development. Impacts from non oil and gas development are relatively small compared to those from oil and gas development and have impacted approximately 2,500 (1,800 villages + 700 DEW sites) acres. The amount of area that would be disturbed by expansion of villages is projected to increase by 2% annually for the next 40 years or so and then level off (see **section 4.7.2.1**). Assuming community infrastructure and footprint grow at roughly the same pace as population, there would be approximately 3,600 acres of community footprint by the time population may level off in the 2040s. In addition, approximately 700 acres of soil impacted by DEW line sites are expected to persist. Therefore the total long term cumulative impact to soil resources on the North Slope from non oil and gas activities (past, present, and foreseeable future) would be approximately 4,300 (3,600 villages + 700 DEW sites) acres.

The total of direct and indirect, long term impacts to soils from past and present oil and gas activities on the North Slope covers approximately 35,000 acres. Impacts to soil resources from future oil and gas development include exploration activities and construction of gravel pads, gravel roads, gravel airstrips, gravel staging areas, excavation of material sites, oil pipelines, and possible gas pipelines (both to market outside the North Slope and within the North Slope). The duration of the impacts would range from short term (< 1 to 5 years) if the soil was lightly disturbed (i.e. most seismic activity, ice roads, and ice pads) up to several decades or longer if the soil was covered by gravel, removed, or permafrost was thawed creating thermokarst.

Impacts associated with exploration and development activities in the planning area would be additive with impacts from activities in other portions of the NPR-A and across the North Slope.

Under Alternatives B, C, and D, the northwest portion of Northeast NPR-A is more likely to be developed. Infrastructure such as pipelines and CPFs developed in this portion of the planning area would also make marginal discoveries in the adjacent northeast portion of Northwest NPR-A, and offshore areas to the north of Teshekpuk Lake, more likely to be developed in the foreseeable future. This would create a greater area of soil disturbance than under Alternative A. Overall, the area of soils impacted long term by past, present, and foreseeable future oil and gas development would be approximately 61,000 (35,000 past and present + 26,000 future) acres. The North Slope region is approximately 57 million acres. Therefore, compared to the area of the North Slope, this would be a relatively small area of soils impacted (about 0.1%), even with the entire planning area open for development (Alternative C). If global climate change persists, the cumulative effects to soil from oil and gas development, and non oil and gas development, on the North Slope could be greater than predicted.

Numerous technological advancements have been made during the decades of operations on the North Slope that have allowed current development activities to proceed with less environmental impact to soil resources than previous operations (NRC 2003). However, some short-term disturbance and permanent long-term impacts to soils are inevitable. New innovations in technology that reduce the amount of surface disturbance associated with oil and gas activities, enforcement of regulations that require the assessment and protection of soil resources before ground-disturbing activities can occur, and a slowing of oil and gas development on the North Slope, would contribute to the future protection of soil resources and slow their cumulative loss. Some soil would be restored as sites are abandoned and reclaimed. However, due to the harsh Arctic climate, it could take several hundred years for soil productivity to reach pre-disturbance levels on abandoned pads and roads.

4.7.7.4 Water Resources and Water Quality

Minor cumulative effects to water resources have occurred from non-oil and gas activities on the North Slope. Cumulative effects to water resources from oil and gas exploration and development in the planning area and across the North Slope could result from: 1) potential disturbance of stream banks or lake shorelines from oil and gas operations and the possible subsequent melting of permafrost (thermokarst erosion); 2) temporary blockages of natural channels and floodways during construction of roads and pipelines that would result in the disruption of drainage patterns; 3) increased erosion and sedimentation in rivers and lakes; 4) the removal of water from lakes for ice roads and pads; 5) increased use of the tundra for both oil and gas and non-oil and gas activities; 6) an increased amount of seismic surveys; 7) spills; and 8) removal of gravel from riverine pools and lakes.

4.7.7.4.1 Past and Present Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Activities not related to oil and gas exploration have the potential to impact water resources. Non-oil and gas activities, including scientific excavations, temporary tent camps, overland moves by transport vehicles, aircraft landings and use of gravel strips, boats, use of OHVs such as four-wheel vehicles, snowmachines, hazardous material or debris removal, legacy well

plugging, and spills, all have the potential to impact water resources and quality. These impacts are usually localized and result in short-term impacts for up to a few years.

DEW-Line sites and other military facilities, villages, public roads, airstrips, and other non-oil and gas infrastructure have been developed using gravel pads or on bare ground. Approximately 2,500 acres have been impacted, and these activities have impacted water quality and altered natural drainage patterns. These effects on water resources are likely to persist into the indefinite future.

Oil and Gas Exploration and Development Activities

Seismic Activities and Exploration. Much of the NPR-A has been surveyed since 1940, and seismic activities have disturbed the soil, vegetation, and water over much of the NPR-A. Studies of seismic and camp-move trails created on the eastern part of the North Slope in the 1980s showed that only 3% of seismic trails were still evident 8 years later, and none of this showed moderate to high disturbance. Yet 10% of camp-move trails still showed minor disturbance, 4% showed moderate disturbance, and 1% showed high disturbance (Jorgenson et al. 1996). The greatest damage occurred where the vegetative mat was destroyed and the underlying soil was exposed. This resulted from tracked vehicles or sleds on skids cutting into hummocks, or from Caterpillar operators making a tight turn and dropping the blade too deeply into the snow, leading to localized thermokarst with scars persisting to this day. An estimated 250 acres of tractor trail/tundra scars were created before 1973; about 50 acres remain evident today (NRC 2003). It is likely that this disturbance has impacted nearby water bodies. Use of newer technologies and procedures, including use of vehicles that apply less pressure to the ground and restricting travel to periods when there is adequate snow and frost cover to protect soil and vegetation, have reduced the likelihood of thermokarst erosion and impacts to water quality.

Other potential water quality impacts are associated with older exploration sites with gravel pads, disturbed areas around these pads, exploration airstrips, and gravel exploration roads. Based on Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope (NRC 2003), in 2001, approximately 1,700 acres had been impacted by these sites in the past, and 1,130 acres of disturbance were still evident. Most of these sites were developed before 1977, thus their effects on the landscape, including soil erosion and sedimentation into nearby water bodies, have persisted for decades, and are likely to persist for several more. Over 500 acres of peat roads still showed evidence of thermokarst, even though most of these roads were constructed over 30 years ago.

To date, approximately 100,000 line miles of 2-D seismic data has been collected in the Chukchi Sea Planning area. Geophysical exploration has also occurred in the Beaufort Sea for decades. These surveys have taken place during the open water season. No impacts on water quality from spills have resulted from these surveys.

Water Withdrawals and Use. Ice roads and pads, drilling operations and camps used extensively for winter exploration drilling and testing require substantial amounts of fresh water from nearby lakes. This water is somewhat saline because of the exclusion of ions during the freezing of the upper part of the lake. When this water is used for ice roads and pads it can slightly increase salinity locally as it melts. Local snowmelt quickly mixes with and dilutes this water. Depending on how far water is transported, some portion of the removed water will return to the lake from which it was removed or flow into an adjacent drainage area.

Ice roads require about 1 to 1.5 million gallons (MG) of water per linear mile while ice pads for individual drill sites can require up to 2 MG of water to prepare a 1 foot thick pad. Within NPR-A approximately 513 MG of water from 126 lakes were used to drill 20 wells and construct 23 ice drill pads and roads from 1999-2006. This is in contrast to a permitted volume of 2000 MG from 376 lakes for the same period (USDOI BLM 2006). This averages to 75 MG of water per year or 26 MG per well. Drilling requires water for making drill mud slurries which provide general lubrication, cool the bit, transport rock cuttings to the surface, prevent sloughing from the sides of the drill hole, and provide a weighting medium to prevent the migration of oil and other fluids into the well. Potable water is also used for drinking and other domestic uses in the camp that accompany drill rigs.

Water withdrawals from lakes have the potential to lower water levels if the removed water is not recharged by snowmelt, rainfall, or inundation by rivers following the removal. Lake chemistry changes during winter periods are dominated by ice-formation processes in shallow lakes (Hinzman et. al. 2006). Water withdrawals monitored by previous studies have shown only minor short-term impacts from water withdrawals and lakes monitored have all fully recharged by the end of the following summer after winter water removals (Baker, 2002; Hinzman et al, 2006).

Drainage Patterns. Drainage patterns have been altered by the construction of roads or pads in or across wetlands or drainage areas. To date, over 9,200 acres of gravel pads and roads, and over 400 miles of roadways (excluding the Dalton Highway), have been constructed in association with oil-field development on the North Slope. Much of the gravel fill has been in wetlands where drainage has been blocked by road construction. During spring ice break-up, there is substantial flow across expansive wetlands into lakes and streams. When long stretches of gravel roads or pads interrupt flow, the difference in water surface elevation from one side of the pad or road to the other can create temporary or permanent impoundments which produce high-velocity water flow in the cross-pad or road drainage structures, usually culverts, resulting in localized streambank and thermokarst erosion, channel scour and downstream deposition of sediment. Improper placement or sizing of gravel fill has resulted in erosion from pads or roadbeds adjacent to streams or lakes. Long-term effects would be changes in channel morphology and in the composition of lake and stream bottom materials.

Through 2001, nearly 1,400 culverts and 17 bridges had been installed on the North Slope (NRC 2003). If culverts are not properly installed or sized, water flows can be affected, ice jams form or temporary or permanent impoundments created. Typically, bridges are used where flows exceed 500 cfs, and 60-inch-diameter line pipes are proposed, instead of culverts, for the Alpine Satellite Development (USDOI BLM 2004c). If not correctly sized, engineered, or constructed, impacts to water resources and quality from impoundments, scour, sedimentation, and thermokarst erosion, associated with bridges, culverts, and pipes would persist and accumulate

Gravel Structures. Peat and gravel roads and pads, and gravel mines have caused the direct loss of soil and also led to the indirect loss of soil from thermokarst and alteration of natural drainage patterns. Through 2001, over 500 acres of peat roads still showed evidence of disturbance, even though most of these roads were constructed over 30 years ago. Gravel has been used to construct approximately 9,000 acres of roads and pads, while gravel mines have impacted approximately 6,000 acres. Other impacted areas cover approximately 2,000 acres (NRC 2003, p 44). The total area impacted on the North Slope from this infrastructure adds up to approximately 17,500 (500 + 9,000 + 6,000 + 2,000) acres. Of this amount, approximately 4,500 acres of gravel mines have been reclaimed, but only 70 acres of pads and roads (NRC 2003). Even though the lakes left behind by former gravel mines are considered reclaimed due

to their value as aquatic habitat, the loss of soil resources is permanent. Thus, impacts to soil persist on approximately 17,500 acres.

Construction of gravel pads, roads, and airstrips has altered the moisture regime of tundra near the structure by changing natural drainage patterns and areas where snow accumulates. Snowdrifts caused by gravel structures have increased the wintertime soil surface temperature and increased thaw depth in soils near the structures. These impacts have been exacerbated by dust deposition and by the formation of impoundments. These factors combine to warm the soil, deepen thaw, and cause thermokarst adjacent to roads and other gravel structures (NRC 2003). In flat, thaw-lake plains on the North Slope, one study published in 1987 found that past gravel construction resulted in upslope water impoundment and thermokarst erosion equivalent to twice the area directly covered by gravel (Walker et. al. 1987). However, cumulative impacts recently reported by the National Research Council found that the ratio of direct to indirect impacts from gravel structures such as roads was about one to one (NRC 2003, p.95). If so, the condition of an additional 17,500 acres of soil may have been susceptible to thermokarst erosion and alteration of natural drainage patterns due to hydrologic changes on the North Slope. Based on this information, the total of direct and indirect long term impacts to soils from past and present oil and gas activities on the North Slope covers approximately 35,000 (17,500 direct + 17,500 indirect) acres.

Gravel Mines. Improper siting of gravel-removal pits has resulted in changes to the configuration of stream channels or lakes, stream-flow hydraulics or lake dynamics, erosion and sedimentation, and ice damming and aufeis formation. Gravel removal for permanent gravel roads and drill pads has resulted in over 6,430 acres of surface impacts, with 5,080 of these acres associated with rivers. However, over 4,550 of these river-associated acres have been rehabilitated by conversion into functional habitat for plants and animals, reducing cumulative effects to water resources on the North Slope and, at some sites, providing fish habitat.

Spills and Other Contaminants. Overall, the effects of spills on soil have not accumulated on the North Slope because all but two of the spills have been small and cleanup and rehabilitation efforts have generally been successful (NRC 2003) and ecosystems have generally recovered (Jorgenson 1997). The largest spill in the North Slope oilfields (over 200,000 gallons) occurred in March of 2006. This two acre site met cleanup criteria by May 2006 after backfilling and covering of veggie-mat was completed. This resulted in essentially no impacts to water quality due to the timing of the spill, which allowed cleanup to take place before the spring melt. Long-term monitoring will gauge the success of the restoration efforts. No notable spills into the marine environment have occurred.

Drilling Waste Disposal. In recent years, drilling wastes, which previously were stored in environmentally undesirable surface pits, have been injected into subsurface aquifers for permanent disposal. Although much of the water in aquifers below the impermeable permafrost is too saline to meet standards for a legally protected drinking water, some is not. The North Slope of Alaska is largely classified as wetlands underlain by permafrost, which separates the surface-water system-active layer, lakes, streams-from the relatively isolated and little understood groundwater system of sub-permafrost formations (Williams 1970, Sloan 1987). Although water appears plentiful on the surface, the North Slope has an arid climate, and if a significant supply of fresh water exists in deep aquifers, it could be a valuable resource. There is little known about the effect of drilling waste disposal on subsurface aquifers and its cumulative effect (NRC 2003).

Marine Waters. Offshore activity in the Beaufort Sea has been limited. Activities that affect the quality of marine waters and flow patterns have included construction of gravel islands and causeways and discharges of materials. Only a few small spills have occurred in marine waters to date, but mechanical recovery, the method allowed by current regulations, is not efficient and only removes a small fraction of the spilled oil, especially in broken ice. Concerns about contamination of marine waters center primarily on the potential effects on marine organisms (NRC 2003).

There have been three permitted types of discharges to the Beaufort Sea over the life of the oil fields. First, individual facilities have discharges permitted under USEPA NPDES program. Second, small or localized discharges have been permitted under the North Slope General NPDES Permit. Third, exploratory drilling discharges were permitted under the Arctic General (or Beaufort General) NPDES Permit under either coastal effluent guidelines or offshore effluent guidelines (Wilson 2001).

Permitted NPDES discharges include effluents from seawater-treatment plants, desalination plants, sanitary-waste-processing units, deck drainage sumps (from offshore production facilities, such as Northstar), temporary construction dewatering, and occasional tests of fire suppression with water. These discharges are permitted for a specific facility, and there are monitoring and reporting requirements. The largest discharges under this program are ocean water and peat detritus (Wilson 2001).

Exploratory drilling discharges are covered under the USEPA Beaufort Sea General Permit and include disposal of drill cuttings and fluids from well-drilling operations. Although muds and cutting cannot be discharged onshore, offshore guidelines still allow discharges of muds and cuttings. Monitoring is frequently required as a condition of discharge permits to ensure that discharges do not exceed water quality standards, are not toxic to marine organisms, do not degrade water quality, and do not pose a threat to human health. It is unknown if impacts from discharges to marine water have accumulated.

Past Clean-Up Efforts in the Planning Area. In 1976, a cleanup program was initiated, based out of Point Lonely and Barrow. During the summer of 1976, over 23,500 drums were retrieved and 750,000 pounds of debris collected. In 1977, another 26,500 drums and 485 tons of debris were collected. In 1978, over 2 million pounds of debris were collected, primarily from the Skill Cliff Air Force Tower site and the Navy's Topagoruk and East Topagoruk test well sites. In 1979, another 1.8 million tons of debris were collected at old Navy sites and other sites in the NPR-A. Removal of this material lessened the likelihood of hazardous materials further impacting local water bodies.

Rehabilitation of pads and other disturbed sites began in the late 1970s, with the focus on lowering the drill pads and obliterating their straight edges, filling reserve pits, and revegetating sites. Germination success varied depending upon growing conditions during the summer; wet and foggy summers usually resulted in poor germination. It is estimated that about 550 acres were disturbed during the 1975-1982 USGS exploration program, that revegetation was attempted on 440 acres, and that vegetation became well established on nearly 400 acres by 1982.

In 2004, continued erosion of the northern coastline threatened J.W. Dalton Test Well #1. Approximately 600 feet of coastline eroded into the Beaufort Sea over the previous two years. Mobilization of well plugging equipment, excavation of the reserve pit soil and plugging of the well took place over the following winter. The reserve pit had been sampled prior to the onset of

winter and it was determined that a portion of the pit required excavation due to environmental concerns. The soil was brought to Lonely (3 miles west), bagged into Supersacks, then transported by barge for proper disposal during late summer 2006.

Summary of Past and Present Effects and Their Accumulation

Based on the above analysis, approximately 2,500 acres of direct surface disturbance from non-oil and gas activities have impacted water bodies and drainage patterns. By 2001, oil and gas activities will have caused approximately 17,500 acres of direct impacts to lands on the North Slope, and indirect impacts to water resources may have occurred on another 17,500 acres. Since most of these impacts are associated with ongoing non-oil and gas residential and commercial development, and oil and gas activities, these impacts to water are additive to future impacts and would be likely to persist for several decades or more. Water withdrawals are required for all oil field operations. Permit regulations have maintained water quality and quantity in lakes as natural recharge processes have been sufficient to recharge the lakes each year. Over 400 miles of oilfield roads (excluding the Dalton Highway) have been constructed by 2001, resulting in approximately 1400 culvert locations and 17 bridges. Streambank erosion, scour and sedimentation have been experienced at stream crossings due to inadequate design in the placement of structures, culverts, or bridges. This has altered natural sediment transport and deposition, creating scour holes or channel bars and impounding water. Several spills have occurred on the North Slope, but their effects have been minor and have likely not accumulated. Effects of discharges from offshore facilities and subsurface injection of drilling wastes are largely unknown, but likely have had little cumulative effect on water quality on the North Slope. Large amounts of debris was left on the North Slope from exploration and military activities from 1940 to 1970 that impacted water quality, but clean-up efforts since the 1970s have removed some of the remaining debris.

4.7.7.4.2 Future Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Non-oil and gas activities will continue to have minor impacts on water resources and water quality. Activities include scientific excavations, temporary tent camps, overland moves by transport vehicles, aircraft landings and use of gravel strips, boats, and use of OHVs such as four-wheel vehicles, and snowmachines, hazardous material or debris removal, and spills, all have the potential to impact water resources and quality. These impacts are usually localized and result in short-term impacts for up to a few years. DEW-Line sites and other military facilities, villages, airstrips, and other non-oil and gas infrastructure located on the North Slope (nearly all located outside the planning area) are likely to persist into the indefinite future, and for villages, are likely to double from approximately 1,800 acres now to 3,600 acres in the 2040s, causing additional water resource impacts outside the planning area.

Oil and Gas Exploration and Development Activities

Future impacts to water resources and water quality will result from thermokarst erosion from seismic exploration and placement of gravel structures, use of lakes as a water source for ice roads, altered drainage patterns, dust effects created by additional traffic on existing roads, spills, drilling waste disposal, discharges to marine waters, clean up efforts, and abandonment. Offshore oil and gas operations and the use of tankers to transport oil from the TAPS to west coast refineries could have a cumulative effect on marine and estuarine water resources.

Seismic Activities and Exploration. It is expected that three 2-D and two 3-D surveys (see **section 4.2.1.2** for a description of these activities) would be estimated to impact a maximum of approximately 108,000 acres during the life of the activity. The Northwest NPR-A Planning Area IAP/EIS estimates that the total acreage impacted by seismic activity would be approximately 185,000 acres combined for 2-D and 3-D seismic surveys and associated camp train moves over the life of the activity.

To analyze the cumulative impacts of seismic surveys on the North Slope, BLM assumes continuation of the recent experience of up to four seismic crews active there each winter and that the miles of 2-D and 3-D surveys, the associated camp-move miles, and the proportion of 2-D and 3-D surveys anticipated in Northeast NPR-A will over time approximate the average throughout the North Slope. Based on these assumptions, approximately 86,400 acres would be disturbed annually on the North Slope, with approximately 125 acres of that total potentially experiencing thermokarst erosion due to moderate to high levels of disturbance a decade later. Thermokarst erosion would also result from the cumulative effect of seismic activity on the tundra during winter months. These impacts would accumulate and be additive to past effects to water bodies on the North Slope.

Seismic activity has occurred for many years in the Chukchi and Beaufort Sea Planning Areas and is expected to continue in the future during the open water season (April and October) Off shore seismic work includes the use of ice breakers, seismic vessels, support vessels and helicopters. Survey times in the Chukchi Sea Planning Area are expected to average 20 – 30 days and to cover a 200 sq-mi area. Off shore seismic surveys are conducted using an airgun and receiving cable arrays. Impacts to water quality from spills are possible.

Water Withdrawals and Use Oil and gas exploration and development would require substantial volumes of water from lakes. Future water withdrawals are difficult to estimate since locations and amount of drilling activity will greatly determine the amount of ice roads built. From 1999-2006 water use for exploration in NPR-A averaged 75 million gallons (MG) of water per year or 26 MG per well. If 193 wells are drilled over the life of this activity plan, then 5,020 MG of water may be withdrawn using these averages. Water withdrawals from lakes have the potential to lower water levels if the removed water is not recharged by snowmelt, rainfall, or inundation by rivers following the removal. Previous studies have shown lakes to have fully recharged the following breakup after water removals in the winter (Baker, 2002; Hinzman, 2006). Because the best oil prospects within the planning area and the North Slope are located in specific zones, lakes along these primary exploration and development zones would be used extensively for water during the winter months until permanent development is planned. The possibility remains that pumped lakes may not fully recharge the following summer, but is unlikely since most have sufficient recharge areas or connections to other streams or lakes. If any lakes are not fully recharged or have water quality changes, future withdrawals from these lakes will not be permitted until conditions return to a normal state. However, extensive use may have a long-term cumulative impact on the planning area, especially if water is withdrawn from a majority of lakes in a concentrated area.

Water removed for ice roads, pads, drilling and camps, is somewhat saline because of the exclusion of ions during the freezing of the upper part of the lake. When this water is used for ice roads and pads it can slightly increase salinity locally as it melts. Local snowmelt quickly mixes with and dilutes this water. Depending on how far water is transported, some portion of the removed water will return to the lake from which it was removed or flow into an adjacent drainage area. Cumulative impacts are not expected since the impacts will be localized and very small.

Drainage Patterns. Although most roads would be built during the winter months as ice roads, long-term oil and gas development in the planning area and the North Slope would require permanent gravel roads. A total of 320 miles of roadways are projected for developments within Northeast NPR-A. These will likely be in wetlands where drainages are easily altered by road construction and temporary or permanent impoundments are created which divert, impede, or block flow in stream channels, lakes, or shallow-water tracks. Impounded water can produce high flows through culverts which is likely to produce streambank and thermokarst erosion, channel scour and downstream deposition of sediment if culverts are improperly placed or sized. Long-term effects in channel morphology and in the composition of lake and stream bottom materials could result.

The long-term effect of thermokarst erosion on water resources and quality would persist, and new thermokarst erosion would be associated with new disturbance, especially in areas where the wave action of the water would accelerate the removal of the protective soil and vegetative cover. Fine-grained sediments melting out of the ice-rich permafrost would result in increased sediment erosion and changes to stream channel and bed morphology. Assuming that some culverts, bridges and pipes will not be correctly sized, engineered, or constructed, impacts to water resources and quality from impoundments, scour, sedimentation, and thermokarst erosion would persist and accumulate. Since roads pose the single greatest impacting factor (diversions, impoundments, and increased sediment runoff), limiting the length of the roads, or the repeated use of roads, would provide a substantial reduction in impacts to water resources.

Gravel Structures. Development activities that could contribute to cumulative effects to water resources and quality on the North Slope include oil and gas development in other areas, including the Northwest NPR-A; Federal and state offshore oil development (through the construction of supporting onshore infrastructure); state onshore oil development; oil and gas transportation; road construction; and a pipeline to take North Slope gas to market, as well as gas pipelines, assumed in most cases to be buried, to gather North Slope gas to a conditioning plant near the northern terminus of the market gas pipeline. All of these activities involve construction of infrastructure that would impact wetlands within the immediate footprint of the project and indirectly affect water quality through dust, flooding, changes in natural drainage patterns, snow drifting, increased water and air pollution, and oil and chemical spills.

Besides thermokarst and drainage alteration, erosion and sedimentation would be caused by construction activities or vehicular crossings, especially during periods of high stream flow or lake levels. Given that over 95% of the primary proposed development area (Barrow Arch) is comprised of water bodies, numerous bridge and culvert crossings would be needed where roads and pads are constructed. If culverts were properly sized and engineered, impacts to water flow from ice-blocking and other obstructions should be minimized. The major rivers should not be affected because lease stipulations would require bridges rather than culverts at crossings.

Additional construction outside of the planning area necessary to support oil and gas exploration and development in the Planning Area would include an increased number of ice roads and new pipelines. Additionally, interconnected oil and gas infrastructure that extends westward across the planning area may increase the likelihood of development in the Northwest NPR-A Planning Area and, at least under alternatives B through D, in the Beaufort and Chukchi Seas. Impacts may result from water withdrawals and direct loss of wetlands or indirect disturbance associated with construction of a pipeline.

Impacts from pipeline construction and the accompanying gravel extraction, with its resultant erosion and sedimentation, would be similar to those described under the action alternatives.

Though dependent on the actual level and location of implementation, the increase in the overall effect of construction-related activities in the cumulative case would accumulate, but would have a minor affect on water quality.

Gravel Mines. Approximately 2,200 acres of gravel mines may be created by the end of the century. Improper siting of gravel-removal pits could result in changes to the configuration of stream channels or lakes, stream-flow hydraulics or lake dynamics, erosion and sedimentation, and ice damming and aufeis formation. Those changes would in turn result in long-term changes in stream channel and lakeshore sand and gravel-bar formation. While new gravel sites on the North Slope would require permits from the ADFG, it is possible that impedance and diversion of floodwaters, increased erosion and sedimentation, and increased thermokarst erosion adjacent to the material sites could occur. Most recent gravel pits have been sited on the tundra, rather than in rivers to minimize the effects described above. Gravel removal for permanent gravel roads and drill pads, however, would still present a long-term cumulative impact to the planning area and to the North Slope in general.

Spills and Other Contaminants. Overall, the effects of spills on soil have not accumulated on the North Slope because all but two of the spills have been small and cleanup and rehabilitation efforts have generally been successful (NRC 2003). The largest spill in the North Slope oilfields (over 200,000 gallons) occurred in March of 2006; remediation efforts have been completed and long-term monitoring is now occurring. The projected increase in activity levels combined with the potential problem of aging pipelines will result in more spills. Cumulative effects would depend on the location, number, size, and seasonal timing of the spills, and concentrations of hydrocarbons. The quality of freshwater within the planning area should not be affected by any of the developments considered in this cumulative analysis, unless there was a large oil spill within or near a fish-bearing lake. The effects of construction activities should be short term and have the greatest impact in the immediate vicinity of the activity. Construction activities are not expected to introduce or add any chemical contaminants. Removal of water from lakes during the winter months should not affect water quality. Only a large oil spill within or near a fish-bearing lake would present a possible impact to long-term water quality.

Gas Development. If commercial gas development occurs on the North Slope, additional impacts could occur to water resources. Gas pipelines, both the large-diameter pipeline that would take gas south over the Brooks Range to market and those smaller pipelines that would take gas from CPFs to a conditioning plant at the northern terminus of the gas pipeline, would most likely be buried. Buried gas pipelines have the potential to cause thermokarst, subsidence, and erosion problems that could persist beyond the construction phase. If all work on the pipelines is done during winter, these impacts would be greatly reduced

Abandonment. Removal of facilities, particularly roads, bridges, and culverts, would likely cause increased sedimentation and thermokarst erosion immediately after removal. Leaving pads, airstrips, roads, bridges, and culverts in place, particularly without future maintenance, however, would result in longer-term, higher levels of erosion, sedimentation, and upslope impoundment. Leaving the roads in place, but removing bridges and culverts and breaching the roads where culverts had been placed, would reduce upslope impoundment. Ponds could be formed from melting of ice wedges or other ice underlying the gravel facilities. Recovery of disturbed sites on the North Slope is complicated by the fact that any disturbance of the insulating vegetative mat can melt the underlying permafrost, a process that is extremely difficult to reverse and that can continue long after the initial disturbance ends. Recovery times in the Arctic, as elsewhere, depend in part on the nature and extent of disturbance and the type

of habitat affected. Reclamation of oil fields, even over a long period of time, would reduce some of the cumulative effects of impoundments.

Drilling Waste Disposal. Drilling wastes are injected into subsurface aquifers for permanent disposal. Although much of the water in aquifers below the impermeable permafrost is too saline to meet standards for a legally protected drinking water, some is not. There is little known about the effect of drilling waste disposal on subsurface aquifers and its cumulative effect (NRC 2003).

Marine Waters. Offshore activity in the Beaufort Sea has been limited and no oil and gas development has yet occurred in the Chukchi Sea. Activities that affect the quality of marine waters and flow patterns have included construction of gravel islands and causeways and discharges of materials. Only a few small spills have occurred in marine waters to date, but mechanical recovery, the method allowed by current regulations, is not efficient and only removes a small fraction of the spilled oil, especially in broken ice. Concerns about contamination of marine waters center primarily on the potential effects on marine organisms (NRC 2003).

There have been three permitted types of discharges to the Beaufort Sea over the life of the oil fields. First, individual facilities have discharges permitted under USEPA NPDES program. Second, small or localized discharges have been permitted under the North Slope General NPDES Permit. Third, exploratory drilling discharges were permitted under the Arctic General (or Beaufort General) NPDES Permit under either coastal effluent guidelines or offshore effluent guidelines (Wilson 2001). Monitoring is frequently required as a condition of discharge permits to ensure that discharges do not exceed water quality standards, are not toxic to marine organisms, do not degrade water quality, and do not pose a threat to human health. Thus, impacts from discharges to marine water have been minor, are likely to remain that way for future similar development, and are not likely to accumulate. Similar regulation of Chukchi Sea development, should it occur, is anticipated to provide similar protection.

Clean-Up Efforts. Water resources and quality may be impacted through future remediation efforts which may involve plugging of abandoned wells, excavation of reserve pits and contaminated soil, removal of drums and debris and subsequent rehabilitation of affected soils. Removal of this material lessens the likelihood of hazardous materials further impacting local water bodies but may result in localized short-term impacts during clean-up operations and for some time afterwards.

4.7.7.4.3 Global Climate Change

Permafrost. Much research in recent years has focused on the effects of naturally-occurring or man-induced global climate regime shifts and the potential for these shifts to cause changes in habitat structure over large areas. Although many of the forces driving global climate regime shifts may originate outside the Arctic, the impacts of global climate change are exacerbated in the Arctic (ACIA 2004). Temperatures in the Arctic have risen faster than in other areas of the world as evidenced by glacial retreat and melting of sea ice.

The increasing thickness of the active layer above arctic permafrost is likely to cause changes in moisture regimes and the distribution of vegetation types over much of the Arctic in coming years. Thawing of the permafrost may result in increased amounts of surface water in some areas. Areas of permafrost with substrates composed of fine-grained materials may be susceptible to drying, erosion, and desertification (ACIA 2004). Increases in sea level may

inundate low lying tundra areas, increasing salt marsh, aquatic and wet tundra vegetation types and erosion of coastal bluffs (ACIA 2004). Such impacts of climate change could accelerate or exacerbate changes in soil thermal regimes that occur with development, potentially leading to greater impacts associated with thermokarst. Global climate change could lead to increased evaporation and, in turn, to increased precipitation. Over the Arctic as a whole, annual total precipitation is projected to increase by roughly 20% by the end of this century, with most of the increase coming as rain. However, while there is high confidence that temperatures will rise and total annual precipitation will increase, it is not known whether the increase in precipitation will keep up with the warming and rate of evaporation. If precipitation does not keep up with the rate of evaporation, land areas could dry out.

Since oil and gas activities can also cause local thawing of permafrost, the effects of a warming climate would add to the thawing effects of direct and indirect impacts from oil and gas development activities on the North Slope. These cumulative effects would occur locally in areas of surface disturbance described earlier. If the climate continues to warm, the period in which there would be adequate snow and frost on the ground to support seismic and other exploration activities would decrease, and the potential for seismic activities to disturb the soil would increase. The effects of changing climate on permafrost are difficult to predict, and predicting how oil and gas development effects to permafrost might accumulate is more uncertain than predicting climate change (NRC 2003, p 59). However, if the permafrost continues to warm, its ability to support structures would diminish, which could affect development on the North Slope. Thicker gravel may be needed to support structures, and abandoned work pads and roads could become unusable as they are cut up by deep polygonal troughs over thawing ice wedges, or by other thermokarst degradation.

Coastal Erosion. Another adverse effect to water resources and quality as a result of climate warming is increased erosion along coastal boundaries. Rising temperatures are altering the Arctic coastline and changes are projected to continue during this century as a result of reduced sea ice, thawing permafrost, and sea-level rise (ACIA 2004). Thinner, less extensive sea ice creates more open water, allowing stronger wave generation by winds and increasing wave-induced erosion along Arctic shores.

Rising sea level is very likely to inundate marshes and coastal plains, accelerate beach erosion, and force salt water into bays, rivers, and groundwater. Coastal regions with underlying permafrost are especially vulnerable to erosion as ice beneath the seabed and shoreline thaws from contact with warmer air and water. The projected increase in air and water temperature, reduction in sea ice, and increase in height and frequency of storm surges are expected to have a destabilizing effect on coastal permafrost, resulting in increased erosion. Since oil and gas activities can also cause local thawing of permafrost, the effects of a warming climate would add to the thawing effects of direct and indirect impacts from oil and gas development activities along coastal boundaries. These cumulative effects could occur locally in areas of surface disturbance near coastal boundaries.

4.7.7.4.4 Contribution of Supplemental Alternatives to Cumulative Effects

If development occurred in the northern portion of the planning area where much of the high potential for oil exists, 95% or more of the impacted area would likely be wetlands. Impacts from ice road construction would occur on 15,642 to 21,763 acres during the life of the plan, while impacts from ice pads and ice airstrips would occur on another 1,126 to 1,700 acres; these impacts to water quality due to water withdrawals and melting of ice roads and pads would be short-term and would not accumulate. Long-term impacts to water quality from seismic surveys

in the planning area would occur under all alternatives but amount to less than 125 acres per year. Development in the planning area from roads and pads could directly impact water quality on approximately 2,720, 3,060, 3,850, 3,680 acres and have equal indirect impacts to the same acreage for Alternatives A through D, respectively (Table 4.2-G). Gravel mines would also add additional direct impacts of 550, 660, 800, and 700 acres to each of the plans. These impacts would be long-term and would accumulate.

Alternatives B, C, and D would open the northwest portion of the planning area to leasing. Infrastructure such as pipelines and CPFs developed in this area would make oil and gas production in the adjacent northeast portion of Northwest NPR-A and Beaufort Sea more likely to be developed in the foreseeable future. The additional effects of any such development in Northwest NPR-A on water resources would be minimal and difficult to discern from existing effects already analyzed; however synergistic impacts to water resources associated with Beaufort Sea development could be considerable in that a pipeline traversing the northern portion of the planning area may otherwise provide the only means to process and transport oil and gas extracted in offshore areas north and east of Teshekpuk Lake of to TAPS and a gas pipeline, thus supplying a critical prerequisite to offshore development. (See discussion of Northwest NPR-A and Beaufort Sea under **section 4.7.3.3**). Consequently, development would be accelerated or become more likely under these action alternatives compared to Alternative A.

4.7.7.4.5 Conclusion

It is anticipated that villages will continue to grow in the future due to population growth and to provide services and infrastructure to support new oil and gas development on the North Slope. The amount of area that would be disturbed by new development is projected to increase by at least 2% annually for the next few decades. These impacts are additive to the impacts to water bodies that have accumulated in the past and persist today, but in the context of the NPR-A and North Slope, these cumulative impacts would be small. Of this, gravel mining for oil and gas development would account for about 2,200 acres by the year 2100. These actions have the potential to add to the cumulative loss and degradation of water resources. Impacts to water resources and water quality would be additive to past, present, and reasonably foreseeable future impacts on the North Slope. The majority of the impacts would result from oil and gas development activities, with construction of roads, permanent drill pads, and water use from lakes during the winter months being the major contributors. Impacts from activities other than those associated with oil and gas development (including any oil and gas-related roads) would be minor. Because of the abundance of water resources on the North Slope, the overall cumulative impact to water resources on the North Slope and in the planning area would probably be small in magnitude and most impacts would be local in nature. These local impacts could be substantial and long term because of the concentration of promising oil and gas plays in specific areas. There could be synergistic effects on water resources and quality that would take place in the Northwest NPR-A and Beaufort Sea. This would occur if a large discovery in the northwest part of the Northeast NPR-A Planning Area would make economic the development or expansion of an oil field in the northeast part of Northwest NPR-A which would not otherwise have been economically developable, or provide the means to process and transport offshore oil and gas and thus possibly supply a critical prerequisite to offshore development. The implementation of the lease stipulations and ROPs required for protection of water resources under each alternative should reduce the cumulative effect to water resources from oil and gas, and non-oil and gas, activities in the planning area to an acceptable level.

4.7.7.5 Vegetation

Vegetation is a renewable resource; impacts to vegetation do not necessarily accumulate and are often reversible. However, due to the harsh climate and short growing seasons on the North Slope, it may take plants decades to centuries to recover from a disturbance. Oil and gas exploration and development in the planning area are the primary contributing activities, in terms of cumulative effects, on vegetation on the North Slope. The greatest impacts occur where vegetation is removed or buried under gravel or other material that destroys the vegetation. In the long term, global climate change may have a greater and more persistent effect on vegetation on the North Slope than oil and gas activities. Other factors that contribute to the cumulative loss or disturbance of vegetation include permitted activities such as non-oil and gas overland moves and development, scientific data gathering, and recreational use by the public. Additional vegetation may be lost by indirect effects associated with dust from gravel roads and pads, and from alteration of natural drainage flows resulting from development.

4.7.7.5.1 Past and Present Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Non-oil and gas activities, including archaeological and paleontological digs, camps associated with scientific studies, recreational use, overland moves by transport vehicles, and use of OHVs such as four-wheel vehicles and snowmachines, have likely caused the loss of less than 100 acres of vegetation in the planning area. In most cases, loss of vegetation would be temporary, lasting only a few years. Where Caterpillar or similar tractors have been used, or the vegetation has been bladed, vegetation scars persist to this day. An estimated 250 acres of tractor trail/tundra scars were created before 1973; about 50 acres remain evident today (NRC 2003).

DEW-Line sites and other military facilities, villages, public roads, airstrips, and other non-oil and gas infrastructure have been developed using gravel pads or on bare ground cleared of vegetation. Approximately 2,500 acres (1,800 acres of village and public facilities, and 700 acres of military facilities) have been impacted, and this loss of vegetative cover is likely to persist into the indefinite future.

Oil and Gas Exploration and Development Activities

Seismic Activities and Exploration. Much of the ACP has been surveyed since 1940, and vegetation was disturbed to varying degrees depending upon the soil and vegetation type, vehicle type, operator vigilance, and amount of snow cover. Studies of seismic and camp-move trails created on the eastern part of the North Slope in the 1980s showed that only 3% of seismic trails were still evident 8 years later, and none of this area showed moderate to high impacts. Yet 10% of camp-move trails still showed minor and 5% showed moderate to high disturbance (Jorgenson et al. 1996). This compared to values of 11% little to no impact, 64% minor, 23% moderate and 2% high on seismic trails just one to two summers following the activity, and 22%, 52%, 24% and 2%, respectively, for camp-move trails. The greatest damage occurred where the vegetative mat was destroyed and the underlying soil was exposed. This resulted from tracked vehicles or sleds on skids cutting into hummocks, or from Caterpillar operators making a tight turn and dropping the blade too deeply into the snow. As noted earlier, about 50 acres of tractor trail/tundra scars persist today from even earlier work.

Use of newer technologies, including vehicles that apply less pressure to the ground and restricting travel to periods when there is adequate snow and frost cover to protect vegetation,

has reduced the level of impacts to vegetation. In 2001, a study conducted the summer following seismic work, found little to no impacts to tundra under seismic lines on 30% of the plots (versus 11% above) studied (Jorgenson et al. 2003). Minor impacts were found on 66% (versus 64% above) and moderate impacts were found on 4% of the plots (versus 23% above); no plots were highly impacted (versus 2% above). Camp move trails in this study had little or no impacts on 18%, minor impacts on 54%, moderate impacts on 29%, and high impacts on none of the plots (similar numbers to the above study). This study suggests that improvements in the equipment and procedures used for seismic surveys has reduced the amount of impact to tundra, resulting in a higher percentage of tundra in categories of low or little to no impacts and few, if any, highly impacted sites. However, no significant improvement in camp-move technology is evident. Longer-term studies are needed to determine if these impacts persist for more than a few years and accumulate.

Other sources of vegetative loss include exploration sites with gravel pads, disturbed areas around these pads, exploration airstrips, and peat and gravel exploration roads. Based on Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope (NRC 2003), in 2001, approximately 1,700 acres had been impacted by these sites in the past, and 1,130 acres of disturbance were still evident. Most of these sites were developed before 1977, thus their effects on the vegetative landscape have persisted for decades, and are likely to persist for several more decades. Over 500 acres of peat roads still showed evidence of disturbance, even though most of these roads were constructed over 30 years ago.

Oil and Gas Infrastructure. Gravel roads and pads, and gravel mines have caused the direct loss of vegetation, and also led to the indirect loss of vegetation and soil from thermokarst and alteration of natural drainage patterns. For the North Slope as a whole, it is expected that by 2010 gravel will have been used to construct about 9,680 acres of roads and pads in the oil fields, 332 acres of the Dalton Highway, 1900 acres will have been impacted by other oil field related disturbances, and gravel mines will have impacted another 6,430 acres (Table 4.7-H). Approximately 4,500 acres of gravel mines have been rehabilitated but only 70 acres of gravel pads (NRC 2003). Rehabilitation of gravel mines produces primarily fisheries habitat, not tundra vegetation, and rehabilitation of gravel pads has produced mixed results that have not restored areas to original conditions. Thus, direct impacts to vegetation by 2010 will persist on about 18,342 acres (Table 4.7-H).

Construction of gravel pads, roads, and airstrips has altered the moisture regime of tundra near the structure by changing natural drainage patterns and areas where snow accumulates. Snowdrifts caused by gravel structures have increased the wintertime soil surface temperature and increased thaw depth in soils near the structures. These impacts have been exacerbated by dust deposition and by the formation of impoundments. These factors combine to warm the soil, deepen thaw, and cause thermokarst adjacent to roads and other gravel structures (NRC 2003).

The passage of vehicle traffic over gravel pads and roads results in dust and gravel being sprayed over vegetation within about 30 feet of the pad or road, and a noticeable dust shadow out to 150 feet or more. Within 30 feet of gravel structures, the dust and gravel can smother vegetation. The effects of dust on vegetation include early snowmelt, reduced soil nutrient concentrations, lower moisture, an altered soil organic horizon, and higher bulk density and depth of thaw (Everett 1980; Walker and Everett 1987; Auerbach et al. 1997). These studies found that plant species richness was reduced near gravel structures, particularly in naturally acidic soils. A decrease in acidophilus mosses, some lichen species, and certain heath taxa altered species composition (Walker and Everett 1987). In areas that experience heavy dust fallout, native plant communities have been killed and replaced by early-successional colonizers

and species more tolerant of the altered site conditions. The magnitude of these effects depends on the duration of dust exposure (i.e., traffic intensity) and the distance from the source. Traffic volume and speed are generally low on in-field roads, which have limited dust impacts to vegetation, but are higher along the Dalton Highway. In addition to dust effects, hydrologic changes due to road induced changes in surface flow can occur. In general, most changes in the plant community and soil around gravel structures would occur within 164 feet of the structure (Woodward-Clyde Consultants 1983). The ratio of spatial extent of indirect effects (roadside flooding, dust, debris, thermokarst) to spatial extent of direct effects (gravel fill) vary from 8.6:1 to 2.4:1 with an average of 6:1 (NRC 2003). This may be a conservative figure for general application since it was based on studies done primarily in heavily developed portions of the Prudhoe Bay oil field. Using it across North Slope oil facilities in general would suggest that about 60,000 acres have been indirectly affected by gravel fill (9,680 acres gravel footprint plus 332 acres Dalton Highway, times six; Table 4.7-H). These impacts are likely to persist as long as gravel fill remains and vehicle travel occurs on the pads and roads.

The material used for gravel fill can also impact vegetation near gravel structures. Saline material used as fill increases the salinity of water draining off of or leaching through the structure. Increased salinity at a site could alter the species composition of the plant community in the immediate vicinity of the gravel structure, shifting the community toward one comprised of species that are more tolerant of saline conditions (McKendrick 2000).

Spills. Overall, the effects of spills on vegetation have not accumulated on the North Slope because the spills have been small, cleanup and rehabilitation efforts have generally been successful (NRC 2003) and ecosystems have generally recovered (Jorgenson 1997).

Air Quality. The effects of air quality on vegetation near industrial facilities on the North Slope appear to be minimal (Kohut et al. 1994; NRC 2003), although few studies have been conducted. Air quality currently meets Federal and state air quality standards. Based on the few studies that have been conducted, these standards appear to be sufficient to have protected vegetation on the North Slope, although impacts to lichens from SO_2 have been shown to occur at concentrations well below the 3-hour standard (BLM/MMS 1998), and the protection these limits on emissions provide to lichen species have been questioned (NRC 2003).

Summary of Past and Present Impacts and Their Accumulation

Based on the above analyses, approximately 2,500 acres of direct impacts, and 15,000 acres of indirect impacts to vegetation from non-oil and gas activities persist today. By 2010, oil and gas activities will have caused approximately 18,342 acres of direct impacts, and 60,000 acres of indirect impacts to vegetation. Whether these impacts are associated with non-oil and gas residential and commercial development, or oil and gas activities, these impacts to vegetation are additive to future impacts and would be likely to persist for several decades or more.

4.7.7.5.2 Future Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Non-oil and gas activities on the North Slope, including archaeological and paleontological digs, camps associated with scientific studies, recreational use and other activities, overland moves by transport vehicles, and use of OHVs such as four-wheel vehicles and snowmachines, would continue to cause the loss of minor amounts of vegetation. In most cases, loss of vegetation would be temporary, lasting only a few years. DEW-Line sites and other military facilities, villages, airstrips, and other non-oil and gas infrastructure are likely to persist into the

indefinite future, and for villages, are likely to increase in size, causing the loss of additional vegetation. The amount of area that would be disturbed by new development on the North Slope in villages and other public facilities is projected to increase by about 2% annually, approximately doubling by 2045 when human population may level off.

Oil and Gas Exploration and Development Activities

Seismic Activities and Exploration. To analyze the cumulative impacts of seismic surveys on the North Slope, BLM assumes continuation of the recent experience of three to four seismic crews active there each winter and that the miles of 2-D and 3-D surveys, the associated camp-move miles, and the proportion of 2-D and 3-D surveys anticipated in Northeast NPR-A will over time approximate the average throughout the North Slope. Based on these assumptions, approximately 86,400 acres of vegetation would be disturbed annually on the North Slope, with 125 acres of that total still showing moderate to high levels of disturbance a decade later.

Other sources of vegetative loss include exploration sites with gravel pads, disturbed areas around these pads, exploration airstrips, and gravel exploration roads. These have been replaced in recent years by ice roads, airstrips, and drilling pads to reduce costs and environmental effects of gravel construction (Johnson and Collins 1980, Hazen 1997). As a result, only a small amount of vegetation is likely to be effected in the long term by exploration sites and facilities.

Oil and Gas Infrastructure. Development activities that could contribute to cumulative effects to vegetation on the North Slope include oil and gas development in other areas, including the Northwest; Federal and state offshore oil and gas development (through the construction of supporting onshore infrastructure); state onshore oil and gas development; oil and gas transportation; and road construction. All of these activities involve construction of infrastructure that would destroy vegetation within the immediate footprint of the project and indirectly affect vegetation through dust, flooding, changes in natural drainage patterns, snow drifting, increased water and air pollution, and oil and chemical spills that could cause changes in the plant species composition and community types.

The increase in the amount of area disturbed by oil and gas development on the North Slope has slowed in recent years. Before 1988, the oil field road network grew by about 24 miles per year, but only 3 miles per year since 1988. The average rate of all gravel placement was about 421 acres per year before 1988, and only 42 acres per year between 1988 and 2001 (NRC 2003; Table 4.7-F). If the current rates continue into the future for areas outside the Northwest NPR-A and the Northeast NPR-A Planning Area, and the ratio of gravel mine acres to gravel footprint acres remains about 5:1 (see **section 4.2.1.2**), about 1,050 additional acres would be covered by gravel, and 210 acres impacted by gravel mines, in the next 25 years. Approximately 6,300 acres would be indirectly affected by dust, changes in hydrology, and thermokarst. To carry these same assumptions through, another 1,260 acres of vegetation could be destroyed by gravel placement or gravel mines for oil and gas activities between 2035 and 2060, and another 6,300 acres could be indirectly impacted by development. The 42 acres per year increase since 1988 has been in an area where the main road network had already been built. There are currently no roads in the planning area or Northwest NPR-A to support oil field development. Thus per year growth in the planning area (as detailed previously for each of the four alternatives, **sections 4.3.5, 4.4.5, 4.5.5 and 4.6.5**) and Northwest NPR-A (described in the table in **section 4.7.3.3**) would be expected to proceed at a faster rate.

Thus impacts to vegetation will accumulate from the following sources: past non-oil/gas activities, non-oil/gas activities from now until about 2045, past oil/gas activities outside of the planning area and Northwest NPR-A, future oil/gas activities outside of the Northeast and Northwest NPR-A up to 2060, future oil/gas activities in the Northwest NPR-A, and future activities in the Planning Area (Northeast NPR-A). All future impacts are additive to the impacts to vegetation that have accumulated in the past and persist today, but in the context of the entire ACP and North Slope, these cumulative impacts would be relatively small. Based on direct (33,962 acres) and indirect (132,401 acres) impacts that could still persist in 2060, direct and indirect impacts to vegetation from activities on the North Slope would impact approximately 1.3% of the ACP and 0.29% of the North Slope. These estimates do not take into account the quality of the vegetation that would be impacted on the North Slope. If rare plants or unusual or scarce plant communities are harmed or lost, impacts to vegetation could be greater based on qualitative factors. Nor do these figures take into account impacts from construction of a natural gas pipeline from the North Slope to market or burial of gas pipelines within the North Slope from new commercial gas developments. If a natural gas pipeline was built from the North Slope, approximately 23,200 acres would be disturbed during construction, about 4,800 acres of that on the North Slope (TAPS Renewal EIS, p. 4.7-80). Additional acreage would be disturbed through burial of gas pipelines that ultimately deliver gas to a conditioning plant and the gas pipeline that delivers gas from the North Slope. Revegetation along the route of these buried pipelines would occur over several years to decades, or even to over a century in some, usually dryer, areas.

Spills. The amount of oil produced on the North Slope under the reasonably foreseeable future scenario is likely to continue to trend downward. As oil production slows, coupled with improvement in spill prevention and control technologies and training, the potential for effects to vegetation should decline over time. This trend could be countered, however, by an aging pipeline system if that should lead to an increase in pipeline leaks.

Air Quality. Emissions on the North Slope are expected to decrease as the result of an overall downward trend in oil production. Greater reliance on technologies that reduce the need for permanent roads and pads, and reduce the size of the facility footprint, also would result in lower levels of particulate matter emissions. Still, impacts to vegetation from past and future air pollutants could accumulate.

Sensitive Plant Species. Development would be unlikely to have a substantially negative effect on plant species or communities as a whole. However, if facilities were constructed in an area containing a population of a rare plant species, the impacts to that species could be high. Five rare North Slope plant species are known to occur in the planning area, and other rare species are known to occur on the North Slope but have not been documented in the planning area. False semaphoregrass is an aquatic grass that rarely occurs between the pendent grass and sedge zones in lakes and ponds. This species is known in Alaska from only a few locations north and northeast of Teshekpuk Lake. This area would be open to development under Alternatives C and D, but not under Alternative A and only partly under Alternative B. Fewflower draba is known from a few coastal sites from Pitt Point to Barrow. All alternatives provide a buffer protection zone (from development) along the coast, but this species could be further imperiled by accelerated coastal erosion. Drummond's bluebell, Eurasian junegrass and Alaskan bluegrass all occur in dry habitats associated with bluffs, floodplains, river terraces, sand dunes, and rock outcrops. These habitats are potentially sources of gravel fill used during construction and development (NRC 2003) and could be impacted by development in these areas. Because of the limited number of plants comprising these populations, loss of one or more plant populations could be a significant cumulative impact to the species.

Abandonment. The North Slope presents special technical challenges to restoration and recovery. Extremely cold temperatures, meager precipitation (5 to 7 inches per year), and the short growing season lengthen recovery times substantially beyond those possible elsewhere in the United States. Natural recovery of disturbed sites to original soil and plant conditions has been estimated to require 600 to 800 years for upland sites and 100 to 200 years for marsh sites (AOGA 2001).

Recovery of disturbed sites on the North Slope is complicated by the fact that any disturbance of the insulating vegetative mat can melt the underlying permafrost, a process that is extremely difficult to reverse and that can continue long after the initial disturbance ends. Finally, gravel pads and roads, which account for the vast majority of the directly affected habitat on the North Slope, retain moisture and nutrients poorly and thus slow recovery processes.

Recovery times in the Arctic, as elsewhere, depend in part on the nature and extent of disturbance and the type of habitat affected. For example, wet sites tend to recover quickly from light oil spills; dry sites affected by diesel fuel spills recover exceedingly slowly, with little recovery occurring after several decades (Walker 1996). Disturbed areas that would recover relatively quickly in more temperate climates (such as those caused by Caterpillar tractor tracks), can persist for many decades because of melted permafrost.

Reclamation of oil fields, even over a long period of time, would reduce some of the cumulative effects of vegetative loss.

4.7.7.5.3 Global Climate Change

Temperatures in Alaska, and throughout the Arctic, are thought to have fluctuated considerably over the last few centuries (Mann et al. 1999). Despite this fluctuation, the last 100 years appear to have been the warmest century in the last 400 years (Overpeck et al. 1997; IPCC 2001; ACIA 2004). As predicted by global climate models, Alaska's surface air temperature has warmed throughout much of the state since at least the mid-1970s (IPCC 2001, ACIA 2004). Continued warming of the climate could have major effects on the ecosystems of Alaska, particularly the North Slope. However, the large amount of natural variation inherent in the system limits our current understanding of the consequences of climate change.

Chapin et al. (1995) suggested that climate change might be altering the species composition of the Alaskan Arctic tundra. A warmer, wetter environment with a longer growing season could greatly affect the productivity and growth form composition of tundra by causing a more rapid release of nutrients from decomposing soil organic matter (Nadelhoffer et al. 1991). Similarly, changes in the water table, which alter decomposition and nutrient availability, substantially alter the carbon balance of tundra and taiga microcosms (Billings et al. 1983; Funk et al. 1994). These changes may eventually lead to shifts in the composition of Arctic tundra toward increased shrub height and cover extent (Chapin et al. 1995; Sturm et al. 2001; Walker et al. 2006) and increased grass and sedge species. These increases would likely be at the expense of lichen and moss cover (Chapin et al. 1995; Cornelissen et al. 2001; Jorgenson and Buchholtz 2003; Epstein et al. 2004; Walker et al. 2006). These changes have already been observed to some extent on the North Slope. Warmer soil temperatures are likely to increase thermokarst, and increases in sea level may inundate low lying tundra areas, increasing salt marsh, aquatic and wet tundra vegetation types and erosion of coastal bluffs (ACIA 2004). Such impacts of climate change could accelerate or exacerbate changes in soil thermal regimes that occur with development, potentially leading to greater impacts to vegetation from changes associated with thermokarst.

4.7.7.5.4 Contribution of Supplement Alternatives to Cumulative Effects

Impacts from ice road construction would occur on 15,642 to 21,763 acres during the life of the plan, while impacts from ice pads and ice airstrips would occur on another 1,126 to 1,700 acres; these impacts to vegetation would be short-term and would not accumulate. Long-term impacts to vegetation from seismic surveys in the planning area would occur on approximately 150 acres under all alternatives. Development in the planning area could directly impact approximately 3,270, 3,716, 4,649, and 4,378 acres, and indirectly impact 9,343, 10,178, 13,001, and 12,961 acres of vegetation for Alternatives A through D, respectively. These impacts would be long-term and would accumulate. Total, long-term, direct and indirect impacts to vegetation from exploration and development combined would occur on 0.28% (Alternative A) to 0.39% (Alternative C) of the planning area.

The impacts in the planning area would increase the total amount of vegetation on the North Slope impacted by all oil and gas development, and generally would be additive in nature. Exceptions may occur in relation to development in the Northwest NPR-A and Beaufort Sea. Depending on oil prices and where and how much oil is ultimately developed in the planning area, there could be synergistic effects on acreage of vegetation affected in the Northwest NPR-A. This would occur if a large discovery in the northwest part of the planning area would make economic the development of an oil field in the northeast part of Northwest NPR-A which would not otherwise have been economically developable. (See discussion of Northwest NPR-A under **section 4.7.3.3**). This potential scenario is least likely under Alternative A because less acreage in the northwest portion of the planning area would be made available to leasing under this than the other three alternatives.

Synergism could similarly result if development north of Teshekpuk Lake resulted in offshore development being more economically feasible. Such offshore development would likely result in additional vegetation impacts from developments built onshore in support of the activities offshore. This would most likely affect the northern portion of the planning area or the Beaufort Sea coastal portions of the Northwest NPR-A. This scenario is unlikely under Alternative A, because very little coastal area in the planning area would be available for lease and even less for surface development. It would be most likely under Alternative C, somewhat less under Alternative D because of development constraints, and less yet under Alternative B because of lands unavailable for lease.

4.7.7.5.5 Conclusion

The area of vegetation impacted by oil and gas exploration and development, compared to the amount of available habitat on the ACP in Alaska and on the North Slope as a whole, is relatively small. The four alternatives differ in the acreage of vegetation that would be impacted. Alternative A would contribute a smaller amount to cumulative vegetation loss across the North Slope than the action alternatives. Alternative C would result in the greatest loss of vegetation.

Impacts to vegetation on the North Slope from future oil and gas exploration and development are expected to be additive with respect to impacts from other past, present, and future non-oil and gas activities and past and present oil and gas activities. The impacts in the planning area would increase the total amount of vegetation impacted by all oil and gas development, and would be additive in nature except in the following potential cases where synergism is likely. If a large discovery is made in the northwest or northern part of the planning area, it could make additional developments in the Northwest NPR-A or offshore more economically feasible,

resulting in additional vegetation impacts in the Northwest and Northeast NPR-A. This possibility is more likely under Alternative B, C or D than Alternative A.

4.7.7.6 Wetlands and Floodplains

In compliance with Executive Order 11990, Protection of Wetlands and Executive Order 11988, Floodplain Management, BLM has prepared an impact analysis on those areas within the planning area that are considered to have the function and value of wetlands and floodplains, as described in **section 3.3.2, *Wetlands and Floodplains***. Approximately 95% of the planning area would be considered wetlands according to established criteria for determining wetland status. It is likely and therefore assumed that all ground-disturbing actions will be impacting wetlands for the purposes of calculating short and long-term impacts. Resources included in the summary discussion below are used to classify impacts on the function and value of wetlands and floodplains on the North Slope. Impacts to the soil, water, or vegetation resources described below can be interpreted as impacting wetlands to some extent. In floodprone areas, impacts described for soil, water, and vegetation resources can also be interpreted as impacting floodplains. The reader should read the soil (**section 4.7.7.3**), water resources and water quality (**section 4.7.7.4**), and vegetation (**section 4.7.7.5**) resource sections for more detailed information on the cumulative effects to these resources.

4.7.7.6.1 Summary of Past and Present Effects and Their Accumulation

Soil Resources

Based on the analysis for soil resources, and assuming approximately 95% or more of past disturbance areas on the North Slope were wetlands, approximately 2,500 acres of direct impacts to wetland soil from non-oil and gas activities persist today. Oil and gas activities have caused approximately 17,500 acres of direct impacts to soil that persist today; another 17,500 acres of indirect impacts have also occurred, some of which persist today. Therefore, a total of approximately 37,500 (2,500 + 17,500 + 17,500) acres of soil resources on the North Slope still show impacts from all past activities. Since most of these impacts are associated with ongoing non-oil and gas residential and commercial development, and oil and gas activities, these impacts to soil are additive to future impacts and would be likely to persist for several decades or more.

Water Resources and Water Quality

Direct and indirect impacts to wetlands and floodplains from non-oil and gas and oil and gas activities are similar in acreage to those listed within the soil resources section above. Over 400 miles of oilfield roads (excluding the Dalton Highway) have been constructed by 2001, resulting in approximately 1400 culvert locations and 17 bridges. Within floodplains, streambank erosion, scour and sedimentation have been experienced at stream crossings due to inadequate design in the placement of structures, culverts, or bridges. This has altered natural sediment transport and deposition, creating scour holes or channel bars and impounding water. Several spills have occurred on the North Slope, but their effects on water have been minor and have likely not accumulated. Water withdrawals monitored by previous studies have shown only minor short-term impacts from water withdrawals, and lakes monitored have all fully recharged by the end of the following summer after winter water removals (Baker, 2002; Hinzman et al, 2006). Effects of discharges from offshore facilities and subsurface injection of drilling wastes are largely unknown, and it is also unknown what cumulative effect on water quality this has on the North Slope. Large amounts of debris left on the North Slope from exploration and military

activities from 1940 to 1970 have possibly impacted water quality, but clean-up efforts since the 1970s have removed much of this debris and reduced effects to water.

Vegetation

Approximately 2,500 acres of direct impacts, and 15,000 acres of indirect impacts to wetland vegetation from non-oil and gas activities persist today. By 2010, oil and gas activities will have caused approximately 18,300 acres of direct impacts, and 60,000 acres of indirect impacts to wetland vegetation that will persist after 2010, for a total of 78,300 acres. Since most of these impacts are associated with non-oil and gas residential and commercial development, and oil and gas activities, these impacts to wetland vegetation are additive to future impacts and would be likely to persist for several decades or more.

4.7.7.6.2 Summary of Future Effects and Their Accumulation

Soil Resources

Cumulative impacts to soils on the North Slope would occur from activities associated with non oil and gas development and oil and gas development. Impacts from non oil and gas development are relatively small compared to those from oil and gas development and have impacted approximately 2,500 (1,800 villages + 700 DEW sites) acres. The amount of area that would be disturbed by expansion of villages is projected to increase by 2% annually for the next 40 years or so and then level off (see **section 4.7.2.1**). Assuming community infrastructure and footprint grow at roughly the same pace as population, there would be approximately 3,600 acres of community footprint by the time population may level off in the 2040s. In addition, approximately 700 acres of soil impacted by DEW line sites are expected to persist. Therefore the total long term cumulative impact to soil resources on the North Slope from non oil and gas activities (past, present, and foreseeable future) would be approximately 4,300 (3,600 villages + 700 DEW sites) acres.

The total of direct and indirect, long term impacts to soils from past and present oil and gas activities on the North Slope covers totals approximately 35,000 acres. Impacts to soil resources from future oil and gas development include exploration activities and construction of gravel pads, gravel roads, gravel airstrips, gravel staging areas, excavation of material sites, oil pipelines, and possible gas pipelines (both to market outside the North Slope and within the North Slope). The duration of the impacts would range from short term (< 1 to 5 years) if the soil was lightly disturbed (i.e. most seismic activity, ice roads, and ice pads) up to several decades or longer if the soil was covered by gravel, removed, or permafrost was thawed creating thermokarst. Impacts associated with exploration and development activities in the planning area would be additive with impacts from activities in other portions of the NPR-A and across the North Slope.

Under Alternatives B, C, and D, the northwest portion of Northeast NPR-A is more likely to be developed. Infrastructure such as pipelines and CPFs developed in this portion of the planning area would also make marginal discoveries in the adjacent northeast portion of Northwest NPR-A, and offshore areas to the north of Teshekpuk Lake, more likely to be developed in the foreseeable future. This would create a greater area of soil disturbance than under Alternative A. Overall, the area of soils impacted long term by past, present, and foreseeable future oil and gas development would be approximately 61,000 (35,000 past and present + 26,000 future) acres. The North Slope region is approximately 57 million acres. Therefore, compared to the area of the North Slope, this would be a relatively small area of soils impacted (about 0.1%),

even with the entire planning area open for development (Alternative C). If global climate change persists, the cumulative effects to soil from oil and gas development, and non oil and gas development, on the North Slope could be greater than predicted.

Water Resources and Water Quality

Existing and future North Slope development has the potential to cumulatively affect wetlands and floodplains in three ways: by altering the landscape, by withdrawing water for construction and operations use, and by pollution from spills. Further landscape alteration can occur as a direct result of either development or thermokarst action.

Development of oil and gas facilities and associated transportation systems have, and will continue to affect wetlands and floodplains. These impacts are most likely to be related to road development. There is currently approximately 570 miles of road development (including the Dalton Highway) on the North Slope outside of villages. However, these potential impacts can be minimized by proper siting of roadways and bridges and by using construction methods that minimize streambed alteration and erosion impacts.

No cumulative impact to North Slope water supplies from withdrawal of water for construction and operation of any of the alternatives is expected because the annual yield (runoff and refill of lakes) is many times greater than the amount withdrawn. Further, water use peaks during construction, which is a temporary, non-permanent activity and is generally not consumptive, so a continuous minimal increase in water use is not expected. Localized and temporary impacts may occur at those lakes used for water supply.

It is anticipated that villages will continue to grow in the future due to population growth and to provide services and infrastructure to support new oil and gas development on the North Slope. This will result in increased water use by these villages as they draw from local surface water sources, potential developments within the floodplains, and filling of wetlands as village boundaries are extended. The soils section above describes acreages impacted by village growth.

Cumulative impacts to wetlands and floodplains from a historically small release of petroleum hydrocarbons during oil spills and contamination from hazardous materials, while they may occur, are also expected to be localized, limited in extent and persistence, and have minimal impact to the environment. However, with aging oil and gas infrastructure and increased oil and gas development, it is estimated that oil spills will become more frequent.

These impacts are additive to the impacts to water bodies that have accumulated in the past and persist today, but in the context of the NPR-A and North Slope, these cumulative impacts would be small. Of this, gravel mining would account for about 2200 acres by the year 2100. Since the 1980's gravel mines have been sited in upland areas and outside of active floodplains.

Impacts to soil resources from future oil and gas development include exploration activities and construction of gravel pads, gravel roads, gravel airstrips, gravel staging areas, excavation of material sites, oil pipelines, and possible gas pipelines (both to market outside the North Slope and within the North Slope). Acreages of future affected areas from direct and indirect impacts are the same as those listed within the soil section above.

Vegetation

Gravel roads and pads, and gravel mines have caused the direct loss of wetlands, and also led to the indirect loss of wetlands from dust, thermokarst and alteration of natural drainage patterns. Based on direct (33,962 acres) and indirect (132,401 acres) impacts that could still persist in 2060, direct and indirect impacts to vegetation from activities on the North Slope would impact approximately 1.3% of the ACP and 0.29% of the North Slope.

Impacts to floodplains could occur from river channel crossings by pipelines and roads, which could destroy vegetation where bridge pilings or VSMs were required for the crossing. Construction of a buried pipeline for gas or for an oil pipeline under a river channel would also have impacts to floodplain vegetation in portions of the floodplain where the pipeline was buried. These impacts would be additive with impacts from other developments occurring on the North Slope. Nor do these figures take into account impacts from construction of a natural gas pipeline from the North Slope to market or burial of gas pipelines within the North Slope from new commercial gas developments. If a natural gas pipeline was built from the North Slope, approximately 23,200 acres of wetlands would be disturbed during construction, about 4,800 acres of that on the North Slope (USDOI BLM, 2002a). Additional wetland acreage would be disturbed through burial of gas pipelines that ultimately deliver gas to a conditioning plant and the gas pipeline that delivers gas from the North Slope. Revegetation along the route of these buried pipelines would occur over several years to decades, or even to over a century in some, usually dryer, areas.

Much of the gravel used for past construction of roads, pads, and airstrips on the North Slope has been obtained from deposits in river floodplains. Impacts from these activities include habitat modifications, caused by increased braiding and spreading of flows (Woodward-Clyde Consultants 1980, NRC 2003). Established guidelines have largely restricted gravel mining to deep mining in upland pits, which may be flooded upon abandonment to create aquatic habitat including fish overwintering areas (NRC 2003). Approximately 2200 acres of wetland vegetation would be disturbed by the establishment of gravel extraction sites on the North Slope. These impacts would be additive with other impacts to floodplains across the North Slope, but the extent of impact would depend on the availability of gravel from upland areas.

Abandonment

The North Slope presents special technical challenges to restoration and recovery. Extremely cold temperatures, meager precipitation (5 to 7 inches per year), and the short growing season lengthen recovery times substantially beyond those possible elsewhere in the United States. Natural recovery of disturbed sites to original soil and plant conditions has been estimated to require 600 to 800 years for upland sites and 100 to 200 years for wetland sites (AOGA 2001).

Recovery times in the Arctic, as elsewhere, depend in part on the nature and extent of disturbance and the type of habitat affected. For example, wet sites tend to recover quickly from light oil spills; dry sites affected by diesel fuel spills recover exceedingly slowly, with little recovery occurring after several decades (Walker 1996). Disturbed areas that would recover relatively quickly in more temperate climates (such as those caused by Caterpillar tractor tracks), can persist for many decades because of melted permafrost.

Removal of gravel fill has recently been done in wetlands, and preliminary studies suggest that wetland mosaics of vegetation can be restored, although the method is expensive and finding acceptable locations for the fill can be difficult. Open-pit gravel mine rehabilitation typically

involves converting mine sites to wetlands, including lakes, with a channel usually cut between the pit and a stream or river so the site can be accessible to fish. Such sites create potential overwintering habitat for fish, but they also result in the permanent loss of the original habitats. Reclamation of oilfields would reduce some of the cumulative effects of wetlands loss.

4.7.7.6.3 Global Climate Change

The potential for many shallow streams, ponds, and wetlands in the Arctic to dry out under a warming climate is increased by the loss of permafrost (ACIA 2004). In other areas, warming of the surface permafrost could increase the formation of ponds, wetlands, and drainage networks, especially in areas with heavy concentrations of ground ice. Such thawing could also lead to large increases in sediment being deposited in rivers, lakes, and coastal marine environments, potentially impacting aquatic organisms.

Global climate change could alter species composition, increasing the prevalence of deciduous shrubs and decreasing the prevalence of wetland sedges and grasses, and could greatly influence wetlands through hydrological changes. Chapin et al. (1995) suggested that climate change might be altering the species composition of the Alaskan Arctic tundra. Global climate changes may eventually lead to shifts in the composition of Arctic tundra toward more shrub species at the expense of grass and sedge species. Warmer soil temperatures are likely to increase thermokarst and increases in sea level may inundate low lying tundra areas increasing aquatic and wet tundra vegetation types and increase erosion of coastal bluffs (ACIA 2004). Such impacts of climate change could accelerate or exacerbate changes in soil thermal regimes that occur with development potentially leading to greater impacts to vegetation from changes associated with thermokarst.

Another adverse effect to soil resources and permafrost as a result of climate warming is increased erosion along coastal boundaries. Rising temperatures are altering the Arctic coastline and changes are projected to continue during this century as a result of reduced sea ice, thawing permafrost, and sea-level rise (ACIA 2004). Thinner, less extensive sea ice creates more open water, allowing stronger wave generation by winds and increasing wave-induced erosion along Arctic shores.

Rising sea level is very likely to inundate marshes and coastal plains, accelerate beach erosion, and force salt water into bays, rivers, and groundwater. Coastal regions with underlying permafrost are especially vulnerable to erosion as ice beneath the seabed and shoreline thaws from contact with warmer air and water. The projected increase in air and water temperature, reduction in sea ice, and increase in height and frequency of storm surges are expected to have a destabilizing effect on coastal permafrost, resulting in increased erosion. Since oil and gas activities can also cause local thawing of permafrost, the effects of a warming climate would add to the thawing effects of direct and indirect impacts from oil and gas development activities along coastal boundaries. These cumulative effects could occur locally in areas of surface disturbance near coastal boundaries.

4.7.7.6.4 Contribution of Supplemental Alternatives to Cumulative Effects

There could be synergistic effects on acreage of wetland vegetation, soils, and water affected in the Northwest NPR-A from the decision reached in this Northeast NPR-A Supplemental IAP/EIS. This would occur if a large discovery in the northwest part of the planning area would make economic the development of an oil field in the northeast part of Northwest NPR-A which would not otherwise have been economically developable (see discussion of Northwest NPR-A

under **section 4.7.3.3**). This potential scenario is least likely under Alternative A because less area in the northwest portion of the planning area would be made available to leasing compared to the other alternatives.

Synergism could similarly result if development in the Planning Area north of Teshekpuk Lake resulted in offshore development being more economically feasible. Such offshore development would likely result in additional wetland vegetation, soil, and water impacts from developments built onshore in support of the activities offshore. This would most likely affect the northern portion of the planning area or the Beaufort Sea coastal portions of the Northwest NPR-A. This scenario is unlikely under Alternative A, because very little coastal area in the planning area would be available for lease and even less for surface development. It would be most likely under Alternative C, somewhat less under Alternative D because of development constraints, and less yet under Alternative B because of lands unavailable for lease.

If development occurred in the northern portion of the planning area where much of the high potential for oil exists, 95% or more of the impacted area would likely be wetlands. Impacts from ice road construction would occur on 15,642 to 21,763 acres during the life of the plan, while impacts from ice pads and ice airstrips would occur on another 1,126 to 1,700 acres; these impacts to wetlands and floodplains would be short-term and would not accumulate. Long-term impacts from seismic surveys in the planning area would occur under all alternatives but amount to 153 acres. Development in the planning area from roads and pads could directly impact approximately 3,270, 3,716, 4,649, and 4,378 acres and indirectly impact 9,343, 10,178, 13,001, and 12,961 acres for Alternatives A through D, respectively (Table 4.2-G). Up to 800 acres (Alternative C) of wetland vegetation are likely to be disturbed by the establishment of gravel extraction sites in the planning area. These impacts would be additive with other impacts to floodplains across the North Slope, but the extent of impact would depend on the availability of gravel from upland areas. Total, long-term, direct and indirect impacts to vegetation from exploration and development combined would occur on 0.28% (Alternative A) to 0.39% (Alternative C) of the planning area.

Impacts to floodplains could occur from river channel crossings by pipelines and roads, which could destroy vegetation where bridge pilings or VSMs were required for the crossing. Construction of a buried gas pipeline or an oil or gas pipeline under a river channel would also have impacts to floodplain vegetation in portions of the floodplain where the pipeline was buried. Compared to Alternatives A, B, and D, the increased development under Alternative C would likely result in greater impacts, since additional river crossings would probably be necessary and the likelihood of buried river crossings (or possibly of buried gas pipelines) would also increase. These impacts would be additive with impacts from other developments occurring on the North Slope.

4.7.7.6.5 Conclusion

Approximately 95% of the ACP in the planning area consists of wetlands; a similar percentage of wetland area was assumed for the North Slope. The ACP is also the area where the most significant oil and gas discoveries have occurred, and where future major discoveries are most likely. In addition, most non-oil and gas development associated with villages and military facilities occurs within this area. Thus, wetlands and floodplains have been affected by past activities, and will be susceptible to effects from future development. New technologies, including use of low-impact equipment and less reliance on gravel roads and pads have reduced the potential for impacts to wetlands and floodplains. Cumulative effects from human-induced activities on the North Slope, coupled with the potential cumulative effects of climate change in

the arctic, could result in substantial alteration of North Slope wetland soil, water, and vegetation in the future.

The area of wetland vegetation impacted by oil and gas exploration and development, compared to the amount of available habitat on the ACP in Alaska and on the North Slope as a whole, is relatively small. Impacts to wetlands on the North Slope from future non-oil and gas and future oil and gas exploration and development are expected to be additive with respect to impacts from other past and present activities. The area impacted by oil and gas development, relative to the amount of available habitat on the ACP in Alaska and on the North Slope as a whole, is relatively small, even if development occurs in the planning area.

Under Alternatives B, C, and D marginally economic fields in the northeast portion of Northwest NPR-A, and offshore areas to the north of Teshekpuk Lake, are more likely to be developed. Additional development in these areas would create a greater area of disturbance to wetlands and floodplains. However, the cumulative area of wetlands and floodplains impacted from future oil and gas development in the North Slope under any of the alternatives would still be minor compared to the total area of the North Slope.

4.7.7.7 Fish

4.7.7.7-a. Freshwater, Anadromous/Amphidromous, and Marine Fish

The life cycles of freshwater and diadromous fishes on the North Slope are adapted to the region's long winters and low productivity (Craig 1984, 1989a, b; Power 1997). After break-up, fish move quickly during the brief summer into many habitats, often at great distances from the wintering area. For example, Arctic cisco from the Colville River can return to spawning areas more than 370 miles from the wintering area (Gallaway and Fechhelm 2000) and many broad whitefish and Arctic grayling make intra-annual migrations between major river drainages (Morris 2003; Morris et al. 2006a). Locating a suitable wintering area at the end of the summer is critical to survival. Craig (1989a, b) estimated that substantially less than 5% of stream habitat remains available to fish by late winter. These widespread movements, and the greatly restricted area of habitat available to fish in winter, make many of these species highly vulnerable to the effects of oil and gas exploration and development.

Marine fish are much less vulnerable to impacts from oil and gas exploration and development in the planning area. Because all scenarios considered within this document deal only with onshore, rather than offshore, actions, there are a limited number of activities that may affect marine species. However, some marine fish that heavily utilize the coastal zone and make migrations into freshwater, such as fourhorn sculpin and Arctic flounder, will be more exposed to potential impacts.

A number of effects could impact fish on the North Slope and accumulate. These include subsistence fishing; disturbance of fish during seismic operations; loss and alteration of habitat due to exploration and development, including effects from altering drainage patterns, water quality, water withdrawals, and causeways; spills; and global climate change.

4.7.7.7-a.1 Past and Present Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Non-oil and gas activities, including archaeological and paleontological digs, camps associated with scientific studies, recreational use, overland moves by transport vehicles, and use of OHVs such as four-wheel vehicles and snowmachines, have likely caused surface disturbance on less than 100 acres in the planning area (NRC 2003). Where Caterpillar or similar tractors have been used, or the vegetation has been bladed, scars in the vegetation persist to this day. An estimated 250 acres of tractor trail/tundra scars were created on the North Slope before 1973; about 50 acres remain evident today (NRC 2003).

Of the 17 species taken by subsistence fishermen on the North Slope, Arctic cisco and broad whitefish have the highest subsistence value. Most subsistence fishing occurs during the summer and fall and is especially important to the coastal villages. An average of 40,800 pounds of Arctic cisco was harvested annually from the Colville River Delta each fall from 1985 to 1998, with an additional 7,100 to 8,800 pounds taken near Kaktovik (Craig 1987; Fuller and George 1997). The broad whitefish harvest by North Slope villages is estimated to be more than 62,000 pounds annually (Fuller and George 1997; Hepa et al. 1997), although in some years fish harvests can be considerably larger. Despite the long history of the Arctic cisco subsistence fishery conducted by Nuiqsut residents, harvest rates from 2004 to 2006 were some of the highest observed during twenty years of monitoring (MJM Research 2005f, 2006a; personal communication with Larry Moulton, 2007). Similarly, broad whitefish continue to be harvested at substantial levels year after year in the Teshekpuk Lake region.

Based on surveys conducted in the late 1980s and early 1990s, Barrow residents harvested from 50,000 to 110,000 pounds of fish per year, or about 11% of the total subsistence harvest (see Appendix J). The estimated harvest of whitefish for Barrow in 1989 was over 90,000 pounds (SRBA and ISER 1993). Atqasuk residents harvested approximately 12,000 pounds of fish annually, or 37% of their subsistence harvest. Nuiqsut residents harvested from 50,000 to 90,000 pounds of fish annually, or 30% of their subsistence harvest. Only a few thousand pounds of fish were harvested annually by Anaktuvuk Pass residents. Small numbers of fish are caught by recreational fishermen during float trips on the Colville River and fishing near villages. Fish harvested for subsistence and recreational purposes comprise only a small portion of the fish population and these effects to fish at the population level do not appear to accumulate based on the current high productivity of the subsistence fishery.

Some fish habitat has been lost due to construction of DEW-Line sites and other military construction, and residential, commercial, and industrial development associated with villages and airstrips. Approximately 2,500 acres have been disturbed by these developments, but since these sites were often located on high ground, there would have been only minor loss of fish habitat.

Oil and Gas Exploration and Development Activities

Seismic Activities and Exploration

When seismic exploration was conducted with explosives, there was potential for harming fish that were exposed to large, rapid changes in ambient pressure. The advent of vibrating equipment has reduced this concern, because the energy it generates is much less than the energy generated by explosives. The ADFG blasting standards require that the instantaneous change in pressure resulting from any explosion must remain below 0.02 megapaseals (Mpa; 2.7

psi). Results of a recent field test involving vibrators on ice, over water, indicate that peak pressure changes below a vibrator can be as low as 0.01 Mpa (1.57 psi). A study by ADNR (Morris and Winters 2005) that exposed fish to Vibroseis noise observed no mortalities and found no indication of physiological damage. Acute mortality from acoustic energy may be a problem primarily associated with explosive-based sources (Wright 1982; Cott et al. 2003), a method that has not been used in recent years in the Alaskan Arctic. Mortalities that may have occurred from seismic exploration conducted with explosives would have been localized and not discernible at the population level. Regardless of method, throughout the history of seismic exploration it is unlikely that impacts to fish populations have accumulated from seismic surveys.

As discussed above, seismic vehicles have impacted the tundra and could have impacted some fish habitat. Use of newer technologies, including use of vehicles that apply less pressure to the ground and restricting travel to periods when there is adequate snow and frost cover to protect vegetation, have reduced the level of impacts to tundra and potential fish habitat. Lease stipulations that require operators to avoid streams or cross at shallow, frozen sections and minimize damage to riparian areas also benefited fish.

Other potential sources of fish habitat loss included exploration sites with gravel pads, disturbed areas around these pads, exploration airstrips, and gravel exploration roads. Approximately 1,200 acres have been impacted by these sites in the past, and 740 acres of disturbance were still evident in 2001. Most of these sites were developed before 1977, thus their effects on the landscape have persisted for decades, and are likely to persist for several more.

Habitat Loss

Peat and gravel roads and pads as well as gravel mines have caused the direct loss of fish habitat, and also led to the indirect loss of fish habitat due to erosion and sedimentation along streams and rivers, and alteration of natural drainage patterns. Through 2001, over 500 acres of peat roads still showed evidence of disturbance, even though most of these roads were constructed over 30 years ago. Gravel has been used to construct over 9,200 acres of roads and pads, while gravel mines have impacted another 6,360 acres. Although much of this development would have occurred in upland areas, over 5,000 acres of mines were associated with streams and rivers (NRC 2003).

Drainage Patterns

Drainage patterns are altered by the construction of roads or pads in or across wetlands or drainage areas. To date, over 9,200 acres of gravel pads and roads, and over 600 miles of roadways, have been constructed in association with oil-field development on the North Slope. In addition to causing the loss of some fish habitat, much of the gravel fill has been in wetlands where cross-pad drainage has been blocked by road construction. During spring ice break-up, there is substantial flow across expansive wetlands into lakes and streams. When long stretches of gravel road or pad interrupt flow, the difference in water surface elevation from one side of the pad or road to the other can produce high-velocity water flow in the cross-pad/road drainage structures, usually culverts, which can inhibit upstream fish movements and delay migration to various summer habitats. The delays are particularly problematic for Arctic grayling, which spawn shortly after break-up and often undertake long, rapid migrations from wintering areas to spawning sites.

An opposite effect can occur in mid- to late summer when stream flow is low. Fish that disperse during or after break-up must leave small drainages and shallow lakes to reach wintering areas

before those waters freeze because there are often limited or no opportunities for overwintering within the habitats used for summer feeding. Fish that cannot leave would freeze. An inadequate number or improper placing of culverts or modifications to the stream bed can cause flow to go below the surface or to be spread too shallow to allow downstream movement when flow levels are reduced in late summer.

Through 2001, nearly 1,400 culverts had been installed on the North Slope (NRC 2003). If not properly installed or sized, water flows can be affected or ice jams can form, impacting fish habitat. Recent investigations into stream crossing structures in the North Slope oilfields found a number of crossings had problems that likely impair or impede fish passage beyond the structures (Morris and Winters 2004, 2007). Typically, bridges are used where flows exceed 500 cfs, and 60-inch-diameter line pipes are proposed, instead of culverts, for the Alpine Satellite Development (USDOI BLM 2004c). If not correctly sized, engineered, or constructed, impacts to fish associated with bridges, pipes, and culverts would persist and accumulate.

Approximately 4,500 acres of gravel mines have been reclaimed, some to provide deepwater habitat for fish; much of the gravel was obtained from gravel deposits within floodplains. But concerns arising from this practice prompted the USFWS to study the effects of floodplain gravel mining on the floodplains physical and biotic processes (Woodward-Clyde Consultants 1980). The study identified numerous examples of habitat modification, including increased channel braiding, loss of wintering areas, spreading of flow, and restriction of fish movements, such as fish mortality caused by stranding. The study also set forth guidelines for gravel mining to minimize floodplain damage (Joyce et al. 1980). In response to agency concerns, and the results of the USFWS study, new gravel mines have primarily been sited in upland sites since the 1980s. Of the 5,080 acres of gravel mines sited in rivers, all but 350 acres were developed before 1973. One benefit of these pits is that they provide freshwater wintering habitat for fish. Since 1989, Arctic grayling have been stocked in several deep gravel pits that now provide fish habitat. According to the NRC (2003), the positive effects to fish from gravel pits likely outweigh the negative effects, and these effects persist today where gravel pits once were.

Water Withdrawal
Use of fresh water has increased in recent years because of expanded oil-field development and increased exploration. In the early years of exploration, water was obtained from any source, including rivers during winter. Bendock (1977 in Winters et al. 1988) documented water withdrawals from the Sagavanirktok River that depleted water in wintering areas and increased mortality to fish in the area. Much of the water needed in the established oil fields is now obtained from reservoirs that are replenished with runoff during spring breakup; most of the water used in exploration is from lakes.

Ice thickness has a great influence on the distribution of fish in lakes across the ACP. Most lakes in the existing development area between the Colville and Sagavanirktok rivers are less than 6 feet deep, few fish are present and effects have been minimal. As development spreads into regions with deeper lakes, such as the Colville River Delta and the eastern part of the NPR-A, there is greater potential for having fish populations within lakes. Under current ADFG and BLM policies, water withdrawals from fish-bearing lakes are limited to 15% of the estimated minimum winter water volume where sensitive species occur and 30% of this volume where resistant species occur. This policy was adopted to allow some water use, while preserving most of the water for wintering fish; the criterion was set arbitrarily because there were no data to support a different use. Studies over the last few years have documented water level recharge and no detectable changes in water quality; in particular, dissolved oxygen (Streever et al. 2001; URS 2001; Baker 2002; Hinzman et al. 2006). Fish populations in lakes subjected to this

maximum allowable withdrawal appear to be unaffected. There has been no research to determine the effects of withdrawals on populations of invertebrates in the lakes or on vertebrate food supplies.

The current practice for ice road construction is to permit withdrawals from a large number of lakes along a desired route, then to allow the ice road contractor to draw from the nearest suitable lake. This allows for maximum construction flexibility, but it complicates the tracking of withdrawal volumes: much more water is permitted for withdrawal than is used. Between 1998 and 2001, for example, Phillips Alaska obtained annual permits for withdrawals of more than 2.2 billion gallons, but used less than 240 million gallons in any given year.

An additional issue associated with water withdrawals from fish-bearing lakes is the potential to remove fish during pumping. In recent years, as construction of ice roads has increased in the vicinity of Nuiqsut, residents have reported finding fish frozen into the roads. Contracts issued for ice road construction specify that water is to be screened to avoid removing fish, but contractors sometimes failed to install screens. In some cases, sampling to identify the presence of fish before water withdrawal used gear that was not appropriate for detecting smaller species, such as ninespine stickleback and Alaska blackfish. The problem can be aggravated when lighted shacks are placed over the hole from which water is withdrawn. Thus, effects to fish from water withdrawals have accumulated, but have not adversely affected fish populations.

Causeways and Intake Pipes

Coastal development that poses the greatest risk of causing effects that accumulate in nearshore habitats includes facilities that change physical conditions that are important to nearshore biota. Such structures include causeways that modify water temperature and salinity. These structures could potentially affect anadromous/amphidromous and marine fish.

Two major causeways have been built into the nearshore region to support oil-field activities. The Prudhoe Bay West Dock was built in the winter of 1974-1975, primarily to support off-loading of large modules used to develop the field; it was modified in 1981 to support the intake structure for the Prudhoe Bay waterflood facility to supply water needed for injection into the oil reservoirs. The causeway runs from the east end of Simpson Lagoon to the west entrance to Prudhoe Bay. The second major causeway, in the middle of the Sagavanirktok River Delta, was built to support facilities for the Endicott oilfield.

Accumulation of effects is a concern when multiple causeways affect the same fish population. The migratory stocks found along the Beaufort Sea coast are likely to encounter multiple causeways during their annual summer feeding movements. From the late 1970s to the late 1980s, there was substantial concern over the potential effects of the two long causeways to migrating fishes, especially for the integrity of the nearshore band of relatively warm, low salinity coastal water that is used by migrating fish Craig (1984). Causeways built perpendicular to shore disrupt the east-west flow of the coastal currents, and can alter fish movements within the band. Permits issued by the USACE and the NSB for causeway construction included lease stipulations for monitoring the effects of the causeway on fish movements and habitat, among other issues. Initial monitoring studied the West Dock Causeway between 1981 and 1984 and then the West Dock and Endicott causeways between 1985 and 1987. In 1988, the USACE concluded that although there were effects to fish, significant harm to habitat had been demonstrated and that further monitoring for effects on fish populations was not required (Hachmeister 1991). Those effects, as summarized by Ross

(1988), included degradation of habitat quality in the nearshore region, alteration to fish movements and fish use of the Prudhoe Bay area, and changes to fish community structure.

The NSB's program showed that the causeways, particularly the West Dock Causeway, interfered with the eastward movement of juvenile least ciscos and humpback whitefish moving from the Colville River into the Prudhoe Bay area during early summer (Moulton et al. 1986a; Fechhelm et al. 1989; Fechhelm 1999; Gallaway and Fechhelm 2000). Juvenile Dolly Varden might also be affected (Hachmeister et al. 1991). The movement of young-of-the-year Arctic cisco from the Mackenzie River into the Alaskan Beaufort Sea region did not appear to be affected by the causeways. Retrofitting of breaches in both causeways in 1994 and 1996 appeared to reduce the effect of the interference to least cisco and humpback whitefish migrations (Fechhelm 1999).

In addition to the causeways, large intake pipes are used to withdraw water from the nearshore region. The Prudhoe Bay waterflood facility, constructed in 1981, can supply 92.4 million gallons of seawater per day. There are also seawater intakes at Endicott (11.6 million gallons per day), and Kuparuk (25.2 million gallons per day). Monitoring of the intakes and marine bypass systems was conducted after start-up for the Prudhoe Bay and Kuparuk waterflood facilities from 1984 to 1987 to assess fish entrapment in intake structures (Dames and Moore 1985-1987). Fish were rarely observed during the monitoring studies, and most of those that entered the system passed successfully. However, approximately 1.5 million fish larvae of nine species were estimated to have been entrapped in the Prudhoe Bay facility in 1985. The intakes were judged to performing as designed, and monitoring was discontinued after 1987.

Spills

Overall, the effects of spills on fish have not accumulated on the North Slope because the spills have been small and cleanup and rehabilitation efforts have generally been successful (NRC 2003). The largest spill in the North Slope oilfields (over 200,000 gallons) occurred in March of 2006, but this resulted in essentially no impacts to fish due to the timing of the spill, which allowed cleanup to take place before the spring melt. No notable spills into the marine environment have occurred.

Summary of Past and Present Effects and Their Accumulation

Non-oil and gas activities, including research camps, village development, and subsistence fishing have impacted fish and their habitat, but these effects have been minor and have likely not had an effect on fish that persists today.

Explosive-based seismic exploration may have injured or killed individual fish in close proximity to this activity, but impacts are not likely to have effected fish populations. The energy produced by vibration equipment used to acquire seismic data is typically below the threshold known to effect fish. Overall, it is probable that impacts to fish from all seismic activities have not accumulated.

Oil and gas activities have caused approximately 18,000 acres of direct impacts to uplands and wetlands that persist today (Table 4.7-H), some of which affect water bodies. These effects accumulate, but do not appear to have adversely affected fish populations on the North Slope. During the early years of development, gravel mining for roads and pads often interrupted both ice sheet flow and stream flows, and hence fish movement. Ineffective bridge and culvert design and placement has reduced the availability of quality habitat. Although the permitting process and the regulatory environment for protecting fish have improved over time, these effects have not been eliminated, and the habitat losses have accumulated.

Some fish have been harmed or killed during water withdrawals, but these numbers are relatively small and probably have not accumulated. Existing causeways near Prudhoe Bay do not affect the westward recruitment of Arctic cisco into the Colville River and associated rearing areas. Blockage of young least cisco and whitefish moving eastward from Colville to Prudhoe Bay was demonstrated under certain wind conditions in some years at the West Dock causeway. This blockage was reduced by the breach retrofit installed in 1996. The effectiveness of breach design for existing or new causeways has not been resolved. Breaches are effective, but there is more to be learned about the best or most appropriate design and placement. Seawater intakes have been designed to prevent entrapment of fishes. There is potential that the effects of causeways do accumulate for fish, although more studies are needed.

4.7.7.7-a.2 Future Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Some fish habitat will be lost due to continued growth of villages, whose footprint is estimated to double to about 3,600 acres by the 2040s and from new developments on the North Slope. Subsistence fishing will continue to remove a small portion of the fish population, as may recreational fishing, although to an extremely small extent. Some of these effects would accumulate, but their impact on fish populations would be minor.

Oil and Gas Exploration and Development Activities

Seismic Activities and Exploration

Concerns related to future habitat degradation from seismic train movement are minimal, given lease stipulations in the 1998 Northeast IAP/EIS ROD, protections proposed in this Supplemental IAP/EIS (e.g., equipment operators would cross streams at shallow riffles), and state regulations. Fuel spills associated with seismic work would be expected to consist of small spills of refined fuel that would be unlikely to reach aquatic habitats, particularly since overland exploration occurs in the winter. The effects of vibration on most overwintering fish should be minimal (short-term avoidance), given the low density of fish in most of the North Slope oil and gas exploration sites during the winter and the short time duration of vibration impulses in any given spot. However, the possibility of damage to sensory cells from Vibroseis noise, which could lead to indirect mortality, has not been eliminated. The use of airgun arrays or explosives during seismic operations has a greater potential to impact fish, although these techniques are much less likely to be used due to advances in technology. Nevertheless, if injury or mortality to fish occurs during seismic operations, it will probably only affect a relatively small number of fish in any given waterbody. As a result, additional seismic activity is unlikely to have a measurable effect on fish populations in the future.

Oil and Gas Production and Development

Given the high potential for oil near the coastline of the planning area and North Slope, it is likely that wetland would comprise 95% or more of the disturbance area and some of this habitat would be used by fish. Considering the density of lakes in the coastal region, positioning of infrastructure in close proximity to fish habitat will be unavoidable. No coastal marine or offshore developments are proposed as part of this IAP/EIS. However, problematic water quality constituents could potentially accumulate in deltas and estuaries and impact marine fish.

Additional construction outside of the planning area necessary to support oil and gas exploration and development in the planning area would include an increased number of ice roads and new pipelines. Additionally, interconnected oil and gas infrastructure that extends

westward across the planning area may increase the likelihood of development in the Northwest NPR-A Planning Area, something that could exacerbate potential cumulative impacts to fish, especially with the increase in pipeline routing underneath stream or river channels. Potential impacts to fish both within and beyond the planning area boundaries would be related to water withdrawal and direct habitat loss or indirect disturbance associated with construction of a pipeline. Increased water use, in and of itself, would not necessarily increase impacts to fish species. Effects would be dependent on the location of withdrawal and amount of water used. Assuming that water withdrawals outside the planning area would also be limited to 15% of the free water volume where sensitive species occur and 30% of this volume where resistant species occur, impacts to fish would be limited to localized, short-term, population abundance and distribution changes. Impacts from pipeline construction and the accompanying gravel extraction, with its resultant erosion and sedimentation, would be similar to those described under the action alternatives. Though dependent on the actual level and location of implementation, the increase in the overall effect of oil and gas construction-related activities would accumulate, but would have a minor affect on fish populations.

Spills
The cumulative case involves the potential for more oil spills. This is due to the projected increase in activity levels and the potential problem of aging pipelines. Many of the North Slope projects considered in the cumulative analysis would be conducted outside of the planning area. The additional oil spills associated with some of these projects could affect the migratory and marine fish that use the coastal areas. Offshore oil spills, or those that occur in rivers and move into coastal waters, would be likely to increase oil-related effects on Arctic fish. Cumulative effects would depend on the location, number, size, and seasonal timing of the spills, concentrations of hydrocarbons, and the life stages of fish exposed to the spills. Lethal effects on fish from oil spills are seldom observed outside of the laboratory environment. For this reason, oil spills are expected to have mostly sublethal effects on the fish affected by them. For example, displacement from oiled water may lead to increased energy expenditures while foraging, with subsequent reduction in growth and reproduction. Juvenile fish that are common in the nearshore area during summer, migratory fish, and nearshore spawners would be among those most likely to experience lethal or sublethal effects. Because in the cumulative case there would be a greater probability of an oil spill contacting coastal waters, it is likely that a greater percentage of fish would be affected. Land-based, cumulative-case oil spills that did not enter coastal waters would be expected to have minor effects on overall fish populations, since the likelihood of a large spill contacting water would be minor. Losses onshore would be greatest in water bodies with limited water exchange. A particular combination of spills under certain circumstances (e.g. in open water) or on repeated occasions in a single drainage would increase the chance for the effects on fish to accumulate to a significant level.

Abandonment
To date, very little abandonment (except for single exploration or development wells) has occurred anywhere on the North Slope. Restoration of other types of facilities, such as gravel extraction sites and older exploration pads, has taken place at a small scale at several locations on state lands on the North Slope outside of the planning area (Jorgenson et al 1992; McKendrick et al 1992; Herlugson et al 1996; McKendrick 1996). These restoration efforts are being closely monitored in an effort to determine the most appropriate and effective methods for restoration.

As with roads, abandonment of bridges and culverts would occur once the economic life of the oil fields had passed. Because the bridges and culverts are an integral portion of the proposed road network, the fate of the bridges would likely be determined by the fate of the road network. If

roads were left in place, but not with the intention that they be maintained for continued use, culverts could be removed and the gravel pads breached to facilitate water flow. If culverts, bridges, or pipes were left in place at abandonment, there is potential that these structures would deteriorate and become clogged, inhibiting water flow and fish passage. If this occurred, the effects to fish would accumulate and persist indefinitely.

Open-pit gravel mine rehabilitation typically involves converting mine sites to lakes, with a channel usually cut between the pit and a stream or river so the site can be accessible to fish. Such sites create potential overwintering habitat for fish, but they also result in the permanent loss of the original habitats. Based on fish use of historic gravel mine sites in the Prudhoe Bay and Kuparuk areas and the limited availability of deep overwintering habitat in the Arctic, the net accumulation of impacts from these sites is likely to be positive.

4.7.7.7-a.3 Global Climate Change

Ice cover in the Arctic Ocean has been shrinking about 3% per decade during the past 2 decades (Johannessen et al. 1999). If this trend continues, the sea ice would disappear entirely during the summer in about 50 years. Some species of fish would benefit from this trend, especially those that reside in warmer waters, while cold-water species would be forced further north. These effects would accumulate in the sense that the range of some species, and subsequently their population size, would continue to increase while the range and population size of other species would decrease. Shifts in species numbers and behaviors could affect subsistence harvests on the North Slope.

Other projected changes to the physical environment associated with future climate patterns could also effect fish populations. As with sea ice, these possible changes would occur incrementally such that the effects would accumulate over time. There is much uncertainty in projecting both the future climate and the potential manifestation of climate changes through habitat alteration. However, observation of some patterns over the last several decades, such as increased thermokarsting and coastal erosion (Mars and Houseknecht 2007), substantiate projected shifts in the physical environment, regardless of their root cause. The following possible changes could lead to detectable shifts in fish species distribution, habitat suitability, and population size and structure: increased lake size due to thermokarsting; flooding of marine waters into coastal lakes due to shoreline erosion; loss of barrier islands due to increased storms and loss of protective sea ice; warmer water, longer open-water period, and less freezedown due to increased air temperature and shorter winter season. Any of these changes could benefit some species while inhibiting other species, and thus could have a negative or positive affect on subsistence harvest.

4.7.7.7-a.4 Contribution of Supplement Alternatives to Cumulative Effects

Seismic activities could disturb almost 105,000 acres of soil under the action alternatives (Table 4.2-F). The number of acres disturbed annually would be similar to the amount of acreage that has been disturbed annually by seismic surveys during the past decade in the planning area. Most impacts of seismic activities outside of the planning area would be limited to the minor impacts associated with ice roads and packed snow trails. Nonetheless, impacts associated with seismic operations, including water withdrawals to make ice roads, occurring in the Northeast NPR-A would be additive with impacts from seismic operations in other portions of the NPR-A and across the North Slope.

Development in the planning area could have a long term impact on an estimated 3,270; 3,716; 4,649; and 4,378 acres for alternatives A through D, respectively (Table 4.2-H). If development occurred in the northern portion of the planning area where much of the high potential for oil exists, 95% or more of the impacted area would likely be wetlands. Considering the density of lakes within these wetlands, positioning of infrastructure in close proximity to fish habitat will be unavoidable. The loss of fish habitat would persist. Impacts associated with the planning area would be additive to past, present, and reasonably foreseeable future soil impacts on the North Slope. Alternatives B, C, and D would open the northwest portion of the planning area to leasing. Infrastructure such as pipelines and CPFs developed in this area would make oil and gas production in the adjacent northeast portion of Northwest NPR-A and Beaufort Sea more likely in the foreseeable future, resulting in greater likelihood of impacts to fish habitat compared to Alternative A. If global climate change persists, the effects to fish could be much greater than predicted, although some species are expected to benefit from global climate change. A portion of the disturbance area would be for gravel extraction (estimated 550, 650, 800, and 700 acres for alternatives A through D, respectively). Although the current emphasis is to extract gravel from upland sites, it could still be possible to create potential overwintering habitat at these sites when abandoned.

4.7.7.7-a.5 Conclusion

Wide-ranging increased impacts to Arctic fish populations found on the North Slope from oil and gas exploration and development would largely depend on the specific location of pads, roads, and infrastructure. Widespread movements required to locate suitable spawning and feeding habitat and the greatly restricted area of habitat available to fish in winter make many of these species highly vulnerable to the effects of oil and gas exploration and development. At a minimum, some effects to fish described above would accumulate. Synergistic impacts to fish at the population level from disturbance related to oil and gas production under any of the alternatives in this supplement are not anticipated, including when increased future activities occurring in Northwest NPR-A and the Beaufort Sea are considered in regard to opening areas north and west of Teshekpuk Lake under Alternatives B, C, and D. Beneficial effects related to material extraction at gravel sites would be possible in certain situations. Past reclamation of deep pits that have been mined has proved beneficial when new habitat for Arctic fish species has been established. If oil and gas activities occurred in areas with high fish populations, or use by sensitive or important subsistence species, impacts to fish could be greater than impacts predicted based on the amount of area impacted.

4.7.7.8 Birds

This section discusses the potential cumulative effects to non-threatened and non-endangered bird species that could result from management actions in the planning area. Approximately 80 species of birds commonly or regularly occur in the planning area. Most of these species, including loons, waterfowl, shorebirds, raptors, passerines, and seabirds are migratory and occur in the planning area only during the summer breeding season. Most of the activities that could potentially contribute to the cumulative effects to birds in the planning area would result from oil and gas exploration and development. Other activities that could potentially contribute to the cumulative effects to birds in the planning area include subsistence activities (including hunting, fishing, berry picking etc.), recreational use, activities associated with scientific surveys and research camps, clean up of old oil and gas exploration sites, and activities associated with government actions (e.g. clean up of abandoned well sites). These activities could affect tundra nesting birds by causing: 1) temporary or permanent habitat loss; 2) various

types of disturbance related to equipment and facility noise, vehicular and air traffic, and pedestrian activities, which could result in displacement from preferred foraging, staging, nesting, molting and/or brood-rearing habitats or decreasing productivity and survival; 3) increased predation from predators attracted to areas of human activity; and 4) mortality resulting from collisions with vehicles or structures, or exposure to contaminants, including oil spills. In addition, any analysis of cumulative effects to birds must include effects to birds on migration and wintering areas, where impacts to birds could be independent of activities on the North Slope. Because bird populations can show substantial changes among years, it is often difficult to determine if effects are accumulating at the population level, or merely reflect short-term shifts in population numbers.

4.7.7.8.1 Past and Present Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Activities that occur on the North Slope and are not directly related to oil and gas development can add to the cumulative impacts to birds. Activities include private or commercial air traffic; aerial surveys to inventory wildlife or other resources; summer research camps; hazardous material or debris removal, recreation activities, village expansion, spills and other environmental contamination, hazardous material clean-up remediation and plugging of legacy wells, predation, and subsistence harvest. These impacts are usually localized and would generally affect only small numbers of birds and would not likely accumulate at the population level.

Research and Survey Activities. Various types of disturbances affect tundra-nesting birds near seasonal camps. Noise and ground activities disturb feeding, nesting, molting and brood-rearing birds, causing temporary or permanent displacement from feeding or nesting areas potentially affecting energy budgets and productivity. Although pedestrian traffic has been shown to be particularly disruptive to some waterfowl and raptors (Roseneau et al. 1981; Ritchie 1987; Johnson et al. 2003b), some birds have acclimated to predictable daily activities of camp personnel. Aircraft activity to mobilize and re-supply summer camps could disturb birds along continually-used flight corridors and near airstrips during take-offs and landings. Effects of this type of visual and noise disturbance could range from temporary displacement from preferred habitats to nest abandonment. Fixed-wing and helicopter flights for mobilization and re-supply of seasonal camps would be intermittent, and could occur several days or weeks apart. It may be easier for birds to acclimate to flights that occur on a regular daily basis than to flights that occur on a more random basis. Birds could also suffer mortality due to collisions with aircraft. Disturbance to birds from aircraft traffic and camp activities is greatest within approximately 2,280 feet of the camps and little or no effect beyond 6,500 feet (Johnson et al. 2003b). Ward et al. (1999) studied brant response to fixed-wing and rotary-wing aircraft and reported brant response to aircraft at a lateral distance to 3 miles, although the majority of birds responded to aircraft that were within a lateral distance of ½ mile or less. The greatest response to aircraft altitude occurred between 1,000 and 2,500 feet. Tundra-nesting birds near seasonal camps could suffer mortality or egg loss due to predators attracted to anthropogenic sources of food at camps. Nest abandonment could occur if nests are located in areas with high levels of activity. Impacts would likely be localized and restricted to within about a mile of activities based at the camp.

Summer boat traffic could occur on the Colville, Kogosukruk, Kikiakrorak, and Ikpikpuk rivers for recreational or subsistence activities, or to re-supply camps along these rivers. Numerous studies have reported on the effects of boat disturbance to birds (e.g., McGarigal et al. 1991;

Steidl and Anthony 1996); this activity could potentially affect nesting gyrfalcons, peregrine falcons, and rough-legged hawks in the Colville River Special Area and the Ikpikpuk River area. The current levels of boat activities on these rivers have apparently not impacted raptors negatively, as some populations, particularly the peregrine falcon population, have been increasing on the ACP in recent years (Ritchie et al. 2003). Fuel spills due to summer boat traffic are expected to be small (less than 5 gallons), and would most likely occur during fuel transfers. Fuel spills have the potential to negatively impact birds if they occur in areas where the birds are feeding (contamination of prey items) or if fuel comes into contact with and adheres to the birds feathers, often causing death. Unless a fuel spill occurred in an area where large numbers of birds were very congregated any such losses would likely be minor to the bird populations on the North Slope, but would contribute to accumulation of effects.

Aerial surveys for wildlife in the planning area could include fixed-wing aircraft and helicopter surveys for waterfowl. Low-level fixed-wing aerial surveys would probably have little effect on birds due to the short amount of time during which aircraft would be in a particular area. Ward et al. (1999) reported a decreasing level of response to aircraft overflights by brant with increasing lateral distance of aircraft. The majority of birds responded at lateral distances of 0.8 km (½ mile) or less. Wildlife telemetry studies involving the use of helicopters could cause greater disturbance to birds due to the take-offs and landings required for deploying ground personnel for attachment of transmitters. Additionally, pedestrian traffic, necessary for transmitter attachment, has been shown to be more disruptive to some waterfowl species than other types of disturbance (Johnson et al. 2003b). The effects to birds from these activities could range from temporary displacement from preferred feeding habitats to nest abandonment and loss of production for the breeding season. Impacts would likely be localized and are unlikely to accumulate at the population level. Impacts have potential to have greater negative effect and potential for accumulation if the activity occurs in an area of high bird density (such as near lakes containing large numbers of molting geese) or in areas containing populations of species listed as Threatened under the Endangered Species Act or on the agency sensitive species list.

Development. Non-oil and gas development in villages has caused the loss of habitat and increased levels of disturbance within the planning area and within the 7 North Slope villages considered in this cumulative effects analysis. The total acres within the city limits of each village are listed in Table 4.7-A with the total acreage for all villages reported to be 60,123 ac. Non-oil and gas development has also caused the loss of habitat and increased levels of disturbance at the 2 former military sites in the planning area (Lonely and Kogru) and the 6 former and current military sites within the area of this cumulative effect analysis (Point Lay, Icy Cape, Wainwright, Peard Bay, Point Barrow, and Cape Simpson). The total acreage of the 8 present and former military sites within the area of consideration for the cumulative effect analysis is reported to be 7,761 acres with acreage at 2 facilities being undetermined (Table 4.7-C). These sites also provide a potential starting point for hunting trips. Development and loss of habitat and disturbance, coupled with other non oil and gas activities would cause a loss of birds and habitat that would accumulate.

Waste Removal. Clean-up activities at abandoned sites in the planning area could involve the use of fixed-wing aircraft or helicopters to access remote areas. The effects of this traffic would be similar to those described above for conducting aerial surveys or for mobilizing and re-supplying summer camps. Ground activity by workers on foot could be more disruptive to some bird species than other types of disturbance (Johnson et al. 2003b). Impacts would likely be localized. Impacts have potential to have greater negative effect and potentially increased accumulated effect if the activity occurs in an area of high bird density (such as near lakes containing large numbers of molting geese) or in areas containing populations of species listed

as Threatened under the Endangered Species Act or on the agency sensitive species list, or during life-history stages where birds are particularly vulnerable to disturbance. Examples of these periods include raptors nesting on the Colville River and waterfowl molting in substantial numbers north, northeast, or during life-history stages where birds are particularly vulnerable to disturbance.

Oil and Gas Exploration and Development Activities

Seismic Activity and Exploration. The two primary factors associated with seismic activities and exploration that could affect birds on the North Slope are loss of habitat and disturbance. Most seismic surveys and exploration drilling activities occur during the winter months when most birds are not present in the planning area. The exception to winter seismic activities is the unlikely collection of seismic reflection data in aquatic areas (lakes, bays and lagoons) during ice-free periods. The previous use of airguns for boat-based seismic work in Teshekpuk Lake likely displaced loons and waterfowl from preferred feeding habitats while surveys were being conducted. However, these surveys have only occurred a few times in the past, and it is unlikely that effects to birds have accumulated. These disturbance causing activities would have no direct impacts that would accumulate for most species. A few species, including snowy owl, gyrfalcon, ptarmigan, and common raven, which may be present in the planning area during winter, could be temporarily displaced from preferred feeding areas by oil and gas exploration activities. Given that these activities occurred within only a small portion of the North Slope, it is unlikely that these effects have accumulated.

Seismic surveys have been conducted over most of the North Slope since 1940 and vegetation was disturbed to varying degrees depending upon the soil and vegetation type, vehicle type, operator vigilance, and amount of snow cover. Studies of seismic and camp-move trails created on the eastern part of the North Slope in the 1980s showed that only 3% of seismic trails were still evident 8 years later, and none of this area showed moderate to high impacts. Yet 10% of camp-move trails still showed minor and 5% showed moderate to high disturbance (Jorgenson et al. 1996). This compared to values of 11% little to no impact, 64% minor, 23% moderate and 2% high on seismic trails just one to two summers following the activity, and 22%, 52%, 24% and 2%, respectively, for camp-move trails. The greatest damage occurred where the vegetative mat was destroyed and the underlying soil was exposed. About 50 acres of tractor trail/tundra scars persist today from earlier seismic work. Seismic activities could have indirectly affected tundra-nesting birds during the summer breeding season as construction of these ice-roads, snow trails and ice-pads temporarily alter tundra habitats by compressing standing-dead vegetation or delaying the growth and development of vegetation, due to protracted ice melt resulting in, at least a short term, slight accumulation of the effect of reduced bird nesting habitat.

To date, approximately 100,000 line miles of 2-D seismic data has been collected in the Chukchi Sea Planning area. Geophysical exploration has also occurred in the Beaufort Sea for decades. These surveys have taken place during the open water season and would be expected to have had some impact to birds if birds were disturbed or displaced from preferred feeding, molting or staging areas due to activities from offshore seismic surveys. Impacts would have potential to have greater negative effect and potentially increased accumulated effect if the disturbing or displacing activity occurs in an area of high bird density or in areas containing populations of species listed as threatened under the Endangered Species Act or on the BLM sensitive species list.

Other sources of vegetative loss include exploration sites with gravel pads, disturbed areas around these pads, exploration airstrips, and peat and gravel exploration roads. Based on Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope (NRC 2003), in 2001, approximately 1,700 acres had been impacted by these sites in the past, and 1,130 acres of disturbance were still evident. Most of these sites were developed before 1977, thus their effects on the vegetative landscape have persisted for decades, and are likely to persist for several more decades resulting in an accumulated effect of loss of bird habitat. Over 500 acres of peat roads still showed evidence of disturbance, even though most of these roads were constructed over 30 years ago likely resulting in an small accumulated effect of loss of bird habitat. However, some evidence suggests that bird use of peat roads is similar to that of adjacent areas of undisturbed tundra (TERA 1991). As industry has shifted towards use of ice roads and ice pads during exploration, loss of habitat has slowed greatly.

Water used in the construction of ice roads and pads would be withdrawn from deep lakes in areas adjacent to the road and pad locations. Winter water withdrawal could alter lake levels and adjacent birds habitats, although flooding and recharge during spring break-up would likely minimize the potential for long-term effects (Rovansek et al. 1996). Since use of lakes in the past has varied, and few lakes would have had water withdrawn over several years, it seems unlikely that the effects of past use of lakes for water withdrawals would accumulate.

Infrastructure and Road and Pad Construction. Effects to bird habitat from road and pad construction and gravel mining, and surface disturbance associated with development and production activities, have occurred on the North Slope in the past and persist today. Gravel roads, gravel pads, and gravel mines have caused the direct loss of avian habitat, and also have led to the indirect loss of habitat from the effects of road dust and alteration of natural drainage patterns. For the North Slope as a whole, it is expected that by 2010 gravel will have been used to construct about 9,680 acres of roads and pads in the oil fields, 332 acres of the Dalton Highway, 1900 acres will have been impacted by other oil field related disturbances, and gravel mines will have impacted another 6,430 acres (Table 4.7-H). Approximately 4,500 acres of gravel mines have been rehabilitated but only 70 acres of gravel pads (NRC 2003). Rehabilitation of gravel mines produces primarily fisheries habitat, not tundra vegetation, and rehabilitation of gravel pads has produced mixed results that have not restored areas to original conditions. Thus, direct impacts to vegetation by 2010 will persist on about 18,342 acres (Table 4.7-H). Loss of habitat has accumulated and could limit bird populations that occupy the planning area.

The passage of vehicle traffic over gravel pads and roads results in dust and gravel being sprayed over vegetation within about 30 feet of the pad or road, and a noticeable dust shadow out to 150 feet or more. Within 30 feet of gravel structures, the dust and gravel can smother vegetation.

Construction of gravel pads, roads, and airstrips has altered the moisture regime of tundra near these structures by changing natural drainage patterns and areas where snow accumulates. These changes alter the species composition of the plant community near gravel structures and adversely affect birds. These impacts have been exacerbated by dust deposition and by the formation of impoundments. These factors combine to warm the soil, deepen thaw, and cause thermokarst adjacent to roads and other gravel structures (NRC 2003). However, impoundments created by road and pad construction and dust deposition have created new feeding and brood-rearing habitat that has been beneficial to some bird species. Noel et al. (1996) reported that the areas occupied by impoundments in the Prudhoe Bay area generally supported higher waterfowl densities than the same areas did prior to development. Kertell

(1993, 1994) reported few differences in invertebrate numbers and numbers of Pacific loons when comparing use of natural ponds and impoundments in the Prudhoe Bay area. He also reported that ducks were more abundant on impoundments than natural ponds, although this difference was not statistically significant. These effects, both beneficial and adverse, persist today on approximately 18,000 acres of vegetation on the North Slope (NRC 2003; Table 4.7-H).

Disturbance. Numerous types of disturbances could result from oil and gas exploration, development, and production activities, including those caused by aircraft, vehicular, pedestrian, and vessel traffic, construction and drilling activities, noise and activity at facilities, and predator attraction. Some level of disturbance to birds from these activities would be unavoidable. Impacts have been most prevalent where facilities were located in habitats with high bird concentrations.

Disturbance to waterfowl from aircraft is well documented (e.g., Schweinsburg 1974; Ward and Stehn 1989, Derksen et al. 1992; McKechnie and Gladwin 1993; Ward et al 1999). Johnson et al. (2003b) conducted the most thorough study of aircraft disturbance to waterfowl in the Arctic at the Alpine field. Responses of birds to aircraft included alert postures, interruption of foraging behavior, and flight. Aircraft disturbances could displace birds from feeding habitats and negatively impact energy budgets. However, an avian monitoring study at the Alpine field showed that successful white-fronted goose nests were generally closer to the Alpine field airstrip, the flight path, and the nearest gravel source than unsuccessful nests, although most comparisons were not substantially different. Johnson et al. (2003b) also reported on tundra swans and yellow-billed loons nesting in proximity to the Alpine field airstrip. When compared to pre-construction numbers, waterfowl nests near the airstrip declined in the area within 3,250 feet of the airstrip after construction began (Johnson et al. 2003b). Although the potential exists for displacement of some nesting birds near routinely used aircraft landing sites as a result of numerous overflights, landings, and takeoffs, some birds may habituate to routine air traffic, while others fail to do so.

During post-breeding studies in southwest Alaska, Ward et al. (1999) studied brant response to fixed-wing and rotary-wing aircraft and reported brant response to aircraft at a lateral distance to 3 miles, although the majority of birds responded to aircraft that were within a lateral distance of ½ mile or less. Brant did not habituate to the overflights, and temporary displacement from preferred nesting, feeding, brood-rearing, or molting habitats could affect energy budgets of some birds, and incubating birds could be temporarily displaced from nests. These effects may have had short-term impacts to brant and other waterfowl, but impacts to local populations were minor. The specific impacts of aircraft to various species of waterfowl occupying the Goose Molting Areas are not known. The cumulative impacts of molting waterfowl to repeated aircraft disturbance is also unknown.

Predators. Predators such as glaucous gulls, Arctic foxes, ravens, and grizzly bears could be attracted to anthropogenic food sources associated with summer maintenance of exploratory drilling and seismic equipment, which may cause increased predation pressure on tundra-nesting birds. There is evidence that nesting success for several species of ground-nesting birds may be lower in oil fields than in undeveloped areas (Troy 1996; Anderson et al. 2000; Sedinger and Stickney 2000). Sedinger and Stickney (2000) attributed low brant nest success in oil fields to high predator populations. Johnson (2000) noted a similar relationship for snow geese in some years. Despite the poor production rates, snow goose and brant numbers have increased in oil fields since the early 1980s. Thus, effects of North Slope development to snow geese and brant are either accumulating, although it is not entirely clear if oil field development has had an adverse (poor reproductive success) or positive (increased population size and growth rates)

effect, or the changes in numbers may be the result of factors outside the breeding or molting grounds (adult or juvenile survivorship).

Increases in the number of predators in areas of development could have an additive impact on the effects of predation on bird populations, particularly for species with low or declining populations or species of special concern such as yellow-billed loon, long-tailed duck, and buff-breasted sandpiper. In recent years, North Slope oil field developers have installed predator-proof dumpsters to minimize attraction of predators to development. This policy has mostly been successful at the Alpine field, where Johnson et al. (2003b) reported no increase in the numbers of predator species, other than the common raven, after development (in relation to pre-development numbers).

Collisions. Bird mortality has resulted from collisions with buildings, vehicles, aircraft, vessels, towers, pipelines, platforms, or other structures associated with onshore and offshore oil and gas development. Offshore activities are most likely to impact birds during the late summer/fall staging period, when relatively large numbers of loons, long-tailed ducks, eiders, and other waterfowl are staging, migrating and molting in marine areas. Migration pathways may include areas where offshore production facilities are constructed, so collisions with offshore structures and with vessel and helicopter traffic used for transport of personnel and equipment, conducting oil spill response exercises or responding to an oil spill, could occur. Bird collisions with vehicles, buildings or oil field infrastructure probably do not represent a significant source of bird mortality at the population level. However, bird losses due to collisions in developed areas accumulate with increases in development and add incrementally to other impacts.

Spills. The largest spill in the North Slope oilfields (over 200,000 gallons) occurred in March of 2006, but this resulted in essentially no direct impacts to birds due to the timing of the spill, which allowed cleanup to take place before the spring melt. Indirect impacts to bird habitat are likely to have occurred as a result of the spilled oil and the subsequent clean up effort. No notable spills into the marine environment have occurred. Small spills have occurred but cleanup and rehabilitation efforts have been successful and relatively few birds have been impacted (NRC 2003) and ecosystems have generally recovered (Jorgenson 1997). The cumulative effects of oil spills on the North Slope have added only incrementally to impacts on birds.

Marine Activities. Offshore oil exploration and development, which occurs in both state and Federal offshore marine waters of the North Slope, rely on helicopter and barge traffic more often than on fixed-wing flights. Most of this activity occurs during the winter when most birds are not present. With the exceptions being those species that winter in recurrent polynynas (E.g. Ross and ivory gulls, thick-billed murre, black guillemot) within the offshore marine waters of the North Slope. However, helicopter activity, barge and crew vessel traffic, and spill response training activities do occur during the summer. During the summer open-water seasons of 2001 and 2002 at the Northstar development off Prudhoe Bay, helicopter activity ranged from 477 to 989 round trips, crew vessel activity ranged from 469 to 824 round trips, and barge traffic ranged from 63 to 64 round trips (Williams 2002, Williams and Rodrigues 2003). Vessel traffic not related to oil development also occurs in marine waters off the coast of the North Slope. These activities have displaced marine birds in the past, but it is unknown if effects have accumulated.

Factors Outside of the North Slope

Wintering grounds and portions of migratory routes of many bird species lie in areas outside of the North Slope, including areas within the U.S. and other several other countries, and regulated or non-regulated development in these areas can impact critical bird habitats. Various types of contaminants and toxins from industrial and agricultural activities can enter either terrestrial or marine environments and affect bird mortality or reproductive success. Oil spills have been an obvious source of bird mortality at numerous locations around the world. Commercial fishing activities have caused changes in predator-prey relationships that could affect wintering loons and waterfowl that feed in offshore marine habitats. Marine birds could also become entangled in fishing gear currently being used in commercial fishing activities or in abandoned gear that persists in marine environments. Many waterfowl species are hunted for sport during the fall migration and on the wintering grounds. Subsistence users take waterfowl or other bird species during spring and fall hunts, as well as eggs of some species during the nesting season. There is evidence that contamination of feeding habitat with spent lead shot may result in lead poisoning of waterfowl in some areas including the Y-K delta. Development along migration corridors and in wintering areas may result in habitat loss or disturbances that add to the cumulative impacts on bird populations. All of these factors can add to the cumulative loss of individual birds, and in some instances, can have population-level effects.

Summary of Past and Present Impacts and Their Accumulation

Approximately 2,500 acres of direct impacts and about 15,000 acres of indirect impacts to bird habitat from non-oil and gas activities persist today. By 2010, oil and gas activities will have caused approximately 18,342 acres of direct impacts, and 60,000 acres of indirect impacts to bird habitat. Whether these impacts are associated with non-oil and gas residential and commercial development, or oil and gas activities, the impacts to bird habitat are additive to future impacts and would likely persist for several decades or more in the absence of an active reclamation program. The typical gravel pad and amount of roadway needed to service a development have become smaller over time, reducing the amount of bird habitat lost due to development as compared to past levels.

Direct and indirect effects from disturbance, of many different types, are difficult to measure, but are likely accumulating as the number of developments and the amount of developed area increase. New oil and gas developments have reduced their footprint size and the corresponding direct effects have been reduced, however these new developments often rely on aircraft support for transportation of personnel and equipment potentially increasing disturbance to feeding, nesting, staging and molting birds. The impacts of predators on bird populations may be slowly waning as industry reduces the amount of predator-attracting garbage in the fields. Habitat loss and disturbance can add incrementally to the impacts of development on birds.

Whether past impacts to bird populations from habitat loss or disturbance are associated with non-oil and gas residential and commercial development, or oil and gas activities, these impacts are additive to any potential future impacts.

4.7.7.8.2 Future Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Non-oil and gas activities as described above would continue to result in the loss of small amounts of bird habitat and cause disturbance to birds. In many cases, loss of habitat from

these activities would be temporary, lasting only a few years. Habitat loss and disturbance associated with military facilities, villages, airstrips, and other non-oil and gas infrastructure are likely to persist into the indefinite future. Villages are likely to increase in size, causing the loss of additional habitat and increase disturbance. The amount of area that would be projected to be disturbed by new development on the North Slope in villages and other public facilities is projected to increase by 2% annually, approximately doubling by 2045 when human population may level off. An increase in non-oil and gas barge traffic is expected due to the recently extended open water period in the Chukchi and Beaufort Seas.

Oil and Gas Exploration and Development Activities

Seismic Activities and Exploration. To analyze the cumulative impacts of seismic surveys on the North Slope, BLM assumes continuation of the recent experience of three to four seismic crews active there each winter and that the miles of 2-D and 3-D surveys, the associated camp-move miles, and the proportion of 2-D and 3-D surveys anticipated in Northeast NPR-A will over time approximate the average throughout the North Slope. Based on these assumptions, approximately 86,400 acres of vegetation would be disturbed annually on the North Slope, with 125 acres of that total still showing moderate to high levels of disturbance a decade later. Seismic surveys on land are known the cause direct and indirect impacts to bird habitat and it is expected that these impacts can accumulate in the short term and to a lesser extent in the long term. Impacts have potential to have greater negative effect and potentially increased accumulated effect if the activity occurs in an area of high bird density or in areas containing populations of species listed as threatened under the Endangered Species Act or on the BLM sensitive species list. Use of newer seismic technology and new methods of moving vehicles across the ground have substantially decreased impacts to bird habitat as compared to seismic surveys that were conducted decades ago and it is expected that there would be very little area of impacts to bird habitat that would persist for greater than a decade.

Seismic activity has occurred for many years in the Chukchi and Beaufort Sea Planning Areas and is expected to continue in the future during the open water season (April and October). Offshore seismic work includes the use of ice breakers, seismic vessels, support vessels and helicopters. Survey times in the Chukchi Sea Planning Area are expected to average 20 – 30 days and to cover a 200 sq-mi area. Offshore seismic surveys are conducted using an airgun and receiving cable arrays. There is potential for birds to be impacted by offshore seismic surveys due to disturbance and potential displacement of birds from preferred feeding, molting and staging areas if bird use areas overlap with seismic activities. Impacts have potential to have greater negative effect and potentially increased accumulated effect if the activity occurs in an area of high bird density or in areas containing populations of species listed as threatened under the Endangered Species Act or on the BLM sensitive species list.

Other sources of habitat loss include exploration sites with gravel pads, disturbed areas around these pads, and airstrips and gravel roads at exploration sites. In recent years, gravel structures for exploration activity have been replaced by ice roads, airstrips, and drilling pads to reduce costs and environmental effects of gravel construction (Johnson and Collins 1980, Hazen 1997). As a result, the long-term effects of exploration activities are likely to affect only a small amount of habitat, although effects would accumulate.

Oil and Gas Roads and Infrastructure. Future oil and gas development activities in the northwestern and southern portions of the NPR-A, Federal and state offshore oil and gas development (through the construction of supporting onshore infrastructure), state onshore oil and gas development, enhanced recovery oil through construction of satellite pads in already

developed areas, and oil and gas transportation could contribute to cumulative impacts on birds through habitat loss or alteration and disturbance. All of these development activities involve construction of infrastructure that would destroy bird habitat within the immediate footprint of the project, and indirectly affect bird habitat through dust deposition, flooding, changes in natural drainage patterns, thermokarst, and snow drifting, increased water and air pollution, and oil and chemical spills that could cause changes in the plant species composition and community types.

The increase in the amount of area disturbed by oil and gas development on the North Slope has slowed in recent years. Before 1988, the oil field road network grew by about 24 miles per year, but since 1988 have grown at only 3 miles per year. The average rate of all gravel placement was about 421 acres per year before 1988, and only 42 acres per year between 1988 and 2001 (NRC 2003; Table 4.7-F). If the current rates continue into the future for areas outside the Northwest NPR-A and the Northeast NPR-A Planning Area, and the ratio of gravel mine acres to gravel footprint acres remains about 5:1 (see **section 4.2.1.2**), about 1,050 additional acres would be covered by gravel, and 210 acres impacted by gravel mines, in the next 25 years. Approximately 6,300 acres would be indirectly affected by dust, changes in hydrology, and thermokarst. To carry these same assumptions through, another 1,260 acres of bird habitat could be destroyed by gravel placement or gravel mines for oil and gas activities between 2035 and 2060, and another 6,300 acres could be indirectly impacted by development.

Impacts to bird habitat will accumulate from the following sources: past non-oil/gas activities, non-oil/gas activities from now until about 2045, past oil/gas activities outside of the planning area and Northwest NPR-A, future oil/gas activities outside of the Northeast and Northwest NPR-A up to 2060, future oil/gas activities in the Northwest NPR-A, and future activities in the planning area (Northeast NPR-A). These impacts are additive to the impacts to bird habitat that have accumulated in the past and persist today, but in the context of the ACP and North Slope, these cumulative impacts would be small. Based on direct (33,962 acres) and indirect (132,401 acres) impacts that could still persist in 2060 (see **section 4.7.5, *Vegetation***), direct and indirect impacts to bird habitat from activities on the North Slope would impact approximately 1.3% of the ACP and 0.29% of the North Slope. These estimates do not take into account the quality of bird habitat that would be impacted on the North Slope. It is likely that the focus of future oil and gas exploration and development would be within the Barrow Arch, which is located in the ACP. Highest population densities of many species of waterfowl and shorebirds are also found in this area; thus, impacts to birds from development and potential for increased accumulated effects would likely be much greater than if estimates of impacts are based solely on size of the facility footprint. Impacts also have potential to have greater negative effect and potentially increased accumulated effect if the activity occurs in areas of high bird densities or areas containing populations of species listed as threatened under the Endangered Species Act or on the BLM sensitive species list.

Additional construction outside of the planning area necessary to support oil and gas exploration and development within the planning area would include increased infrastructure including additional miles of new pipeline. Interconnected oil and gas infrastructure that extends westward across the planning area may increase the likelihood of development in the Northwest NPR-A Planning Area and may facilitate development of offshore oil and gas resources in the Chukchi Sea. If planning area oil and gas infrastructure extends to the north of Teshekpuk Lake there may be increased likelihood of the development of oil and gas facilities offshore of the planning area in the Beaufort Sea. Potential impacts to birds both within and beyond the planning area boundaries would be related to direct and indirect habitat loss or alteration or disturbance associated with construction of infrastructure (roads, pads, pipelines)

and production. The magnitude of the effects to birds would be dependent on the location, extent and timing of any development. It is likely that any of these potential activities listed above could cause impacts to birds to accumulate.

In addition, if a natural gas pipeline was built from the North Slope, approximately 23,200 acres would be disturbed during construction, about 4,800 acres of that on the North Slope. (TAPS Renewal EIS, p. 4.7-80) Additional acreage would be disturbed through burial of gas pipelines that ultimately deliver gas to a conditioning plant and the gas pipeline that delivers gas from the North Slope. Construction, which would take place in winter, could disturb, but unlikely to cause mortality among, ptarmigan, gyrfalcons, snowy owls and ravens. Revegetation along the route of these buried pipelines would occur over several years to decades, or even to over a century in some, usually dryer, areas, thus potentially reducing or altering bird habitat along the route of the buried pipelines.

Disturbance. It is reasonable to assume that increased development would cause increased disturbance to birds. Although there is no clear indication that disturbance effects have accumulated to the point that they are adversely affecting bird populations, the effects of potential future developments outside of the planning area (onshore in Northwest NPR-A Planning Area and east of NPR-A and offshore development in the Chukchi and Beaufort Seas) would be additive to effects of present and past development. If birds are displaced from prime habitat by loss of habitat to gravel infrastructure, and disturbance further displaces birds, the effects of displacement and disturbance could result in energetic costs that reduce survival and productivity. These losses of individual birds would accumulate, and could persist as long as development occurred on the North Slope.

Predators. It is reasonable to assume that development may cause increased potential for predators to be attracted to infrastructure, resulting in local impacts to birds. Although there is no clear indication that predator effects have accumulated to the point that they are adversely affecting bird populations, the effects of potential future developments outside of the planning area (onshore in Northwest NPR-A Planning Areas and east of NPR-A and offshore development in the Chukchi and Beaufort Seas) would be additive to effects of present and past development. If birds are killed or nests predated due to increased numbers of predators in the vicinity of oil and gas infrastructure losses of individual birds would accumulate, and could persist as long as development occurred on the North Slope. Impacts also have potential to have greater negative effect and potentially increased accumulated effect if the activity occurs in areas of high bird densities or areas containing populations of species listed as threatened under the Endangered Species Act or on the BLM sensitive species list. During the early years of oil field development, it is likely that predators were attracted to development by anthropogenic sources of food and shelter. Based on policies implemented by the BLM and private industry to discourage attraction of predators to areas of development, the effects of predators on birds are likely to stabilize or decrease over time. These policies has been successful at the Alpine field, where Johnson et al. (2003b) reported no increase in the numbers of most predator species, except ravens, after development.

Collisions. Bird mortality from collisions with buildings, vehicles, aircraft, vessels, towers, pipelines, platforms, or other structures associated with onshore and offshore oil and gas development is likely to persist into the future, and is expected to increase with increasing levels of development. The oil and gas industry has developed and implemented anti-collision practices, including providing better lighting of facilities, burying power lines, and attaching power lines to pipelines, in an attempt to reduce the number of bird collisions oil and gas infrastructure. Losses from collisions with on-land infrastructure are predicted to be small and

would not be expected to significantly affect bird populations. However, if birds are killed due to increased oil and gas infrastructure losses of individual birds would accumulate, and could persist as long as development occurred on the North Slope. Impacts also have potential to have greater negative effect and potentially increased accumulated effect if the activity occurs in areas of high bird densities or areas containing populations of species listed as threatened under the Endangered Species Act or on the BLM sensitive species list. If development occurs in offshore waters there would be potential for birds to be killed by collisions with offshore infrastructure. During spring and fall migration 450,000+ common and king eiders pass through the Beaufort and Chukchi seas (Day et al. 2003). Due to the fact the eiders fly rapidly and low over the water while migrating and may be attracted to lights, eiders may be highly susceptible to collision with man-made structures. Research at North Star Island (a man-made island in the Beaufort Sea) reports a high success rate for birds passing the island. Very large numbers of shorebirds also use the shorelines, near and offshore waters of the North Slope for staging and migration and would also be susceptible to collisions with man-made structures. Research into developing additional practices to deter birds from both onshore and offshore infrastructure is underway and advances in the development of anti-collision mechanisms have the potential to significantly decrease the number of bird deaths from collisions. Losses from collisions with offshore infrastructure are expected to be small and would not be expected to significantly affect bird populations. However, if birds are killed due to increased oil and gas infrastructure, losses of individual birds would accumulate, and could persist as long as development occurred on the North Slope. Impacts also have potential to have greater negative effect and potentially increased accumulated effect if the activity occurs in areas of high bird densities or areas containing populations of species listed as threatened under the Endangered Species Act or on the BLM sensitive species list.

Spills. The oil industry is required to have oil spill response and clean-up capabilities, and small spills on lands or waters in the planning area or in existing or future North Slope oil fields are expected to be contained and cleaned up before substantial bird loss can occur. In addition to mortality through direct contact with oil, some mortality could result through ingestion of contaminants in food and water, and from the cumulative effects of the numerous small spills expected from the operation of any oil field.

A large onshore spill released in the planning area during the summer season could affect loons, waterfowl, shorebirds, and other bird groups. In the immediate vicinity of the spill, some habitat contacted by oil would become unsuitable for bird use, and oil entering freshwater aquatic habitats could spread more widely, potentially entering river deltas and nearshore marine habitats. Direct mortality could occur from loss of insulating capabilities of feathers should birds come in contact with oil, or from ingestion of contaminated prey. Oil that came in contact with eggs, either directly or through contact with partially oiled feathers of incubating adults, could negatively impact embryonic development. These effects would be additive to the effects of a spill in the existing and potentially expanding North Slope oil fields, or to the effects of potential future spills that could occur in the Northwest NPR-A, if these areas were developed.

If future oil field development were to occur in state or Federal marine waters offshore of the planning area, there would be a minor probability of a large oil spill. If one or more spills were to occur, substantial losses to loons, shorebirds and waterfowl could result if oil were released during the summer/fall season when large flocks of these birds were present. Large numbers of molting waterfowl are known to use the lagoon systems in nearshore areas of the Beaufort and Chukchi seas. Thousands of molting or staging loons and waterfowl could be impacted by an offshore spill occurring in areas of high bird use, such as the lagoon system near Prudhoe Bay in

the central Beaufort Sea or in Kasegaluk Lagoon in the Chukchi Sea. An offshore spill could also affect feeding habitats in littoral habitats, such as extensive mudflats in the Colville River Delta, which are used by staging shorebirds. The Colville River delta supports thousands of postbreeding shorebirds, the most abundant of which is dunlin (Andres 1994). The arcticola subspecies of dunlin is considered to be highly imperiled (Brown et al. 2001). An oil spill could also contaminate prey populations in foraging areas at any time of year, which could result in secondary impacts to loons, waterfowl, and shorebirds by affecting productivity and/or survival.

Tanker spills of crude oil from oil fields in the planning area could impact birds in marine habitats along the entire tanker route from the port at Valdez to West Coast refineries. A large oil spill in the Prince William Sound area, similar to the Exxon Valdez spill in 1989, would impact many thousands of waterfowl and marine birds at any time of the year. Large numbers of loons and waterfowl use Prince William Sound as a migratory stopover or wintering area. The Copper River Delta is a migratory stopover area for millions of shorebirds during spring and fall migration; if an oil spill were to spread to this area, it could impact many thousands of birds. Marine birds and waterfowl could also be impacted by an oil spill in the Gulf of Alaska or in open water or bay habitats along the Pacific Coast of Canada, Washington, Oregon, and California. Oil spills occurring in coastal areas would likely produce greater impacts to birds than a spill occurring several hundred miles offshore, where bird densities are much lower. Spills, such as the Exxon Valdez spill and many smaller spills, have already caused extensive bird mortality in many of these areas. The actual numbers of birds impacted by an oil spill is likely much higher than the number of oiled carcasses recovered, because the carcasses of many oiled birds may never be recovered. The length of time required for populations to recover and the lingering effects of contamination vary among species.

Oil produced as a result of development in the planning area would contribute to less than 13% of future spills from TAPS, but would increase the number of onshore oil spills and would likely impact tundra systems in some instances.

Marine Activities. Offshore oil exploration and development is likely to increase in the future due to recent and upcoming Federal and State lease sales in the Beaufort and Chukchi seas. Development near the coastline in the NPR-A and elsewhere on the North Slope would result in increased vessel traffic in the Chukchi and Beaufort seas. Global climate change could increase the duration of the open-water period and vessel traffic could occur in the region for longer periods of time each year. As a result, effects to birds from vessel traffic and disturbance are likely to persist near current levels into the foreseeable future, and may even increase. This traffic could impact bird habitat use and behavior and cause the death or injury to some individuals, and impact energy budgets and the ability of some birds to store fat prior to migration. If birds are killed, displaced or disturbed due to increased activities in marine waters, losses of individual birds would accumulate, and could persist as long as marine traffic occurred. Impacts also have potential to have greater negative effect and potentially increased accumulated effect if the activity occurs in areas of high bird densities or areas containing populations of species listed as threatened under the Endangered Species Act or on the BLM sensitive species list.

Abandonment. The impacts of abandonment and rehabilitation of oil and gas fields on birds would be similar in many respects to those incurred by construction activity. Activities occurring in the winter would cause little disturbance or displacement, because most species would be absent from the area. However, the melting of ice roads could be delayed, compared to surrounding tundra, causing impoundments of water. Delay in the melting of ice roads, compared to the surrounding tundra, could also cause either complete loss of nesting habitat for

a season or compaction of vegetation, which would reduce the quality of the nesting habitat for a nesting season. Such impacts would only affect nesting in the summer following ice road use, and would likely be minor. Summer road and air traffic generated by abandonment and rehabilitation activities could cause disturbance, displacement, and mortality to birds that would be similar to, and at the same levels as that caused by traffic during construction and operations. If pads, roads, and airstrips were not revegetated, their value to birds would be lessened. If they were revegetated without removing the gravel, the habitat would not return to its current utility for most birds of the area. If gravel was removed, habitat similar to that currently existing in the area could be created and used by birds, though the precise mix of habitat types would likely not be the same as what prevailed at the time of disturbance. The effects of habitat loss would accumulate, as described above, to the extent that habitats were not, or could not be, restored to their original condition.

Other Factors on the North Slope

Numerous other factors could add to cumulative impacts on bird populations. Subsistence harvest of some species of birds and eggs continues to impact these species, although overall numbers of birds and eggs taken over their entire range are not known. Aside from direct mortality due to subsistence harvest, the accumulation of lead shot in waterfowl foraging habitat in the Y-K Delta may be impacting waterfowl survival. It is currently illegal to use lead shot while hunting any bird species on the North Slope. Illegal use of lead shot for hunting waterfowl, could contribute to the effects of lead poisoning on waterfowl populations.

Factors Outside of the North Slope

Wintering grounds and portions of migratory routes of many bird species lie in areas outside of the North Slope, including areas within the U.S. and other several other countries, and regulated or non-regulated development in these areas can impact critical bird habitats. Habitat losses in non-breeding areas could be particularly significant for species of concern or species with low population numbers, such as buff-breasted sandpiper. Habitat losses may occur directly from habitat destruction due to development, or from pollution, such as exposure to agricultural pesticides that may reduce the ability of birds to reproduce or may cause direct mortality to birds. Other activities, such as commercial fishing, may also have the potential to cause changes in predator/prey relationships or damage benthic habitats that could affect some marine bird populations. Numbers of wind farms are increasing in many areas of the United States, including Alaska and in many other areas of the world. These wind farms have the potential to cause direct mortality to birds. Disease, such as west nile virus and potentially avian influenza have the potential to be transmitted to and from the planning area by species that spend a portion of their life cycle in Asia. Impacts related to subsistence hunting and sport hunting in wintering areas and along migratory routes can be additive to the effects of development on the North Slope. Spent lead shot that remains in waterfowl feeding habitat has been linked to lead poisoning for some waterfowl species (Franson et al. 1998). Impacts of subsistence hunting may impact species of concern such as brant, bar-tailed godwit, and threatened eiders as well as many more abundant species. Cumulative effects to birds would be additive and include habitat loss and disturbance related to activities on the migration and wintering grounds that could result in permanent or temporary displacement from preferred feeding and roosting habitats.

4.7.7.8.3 Global Climate Change

Much research in recent years has focused on the effects of naturally-occurring or man-induced global climate regime shifts and the potential for these shifts to cause changes in habitat structure over large areas. Although many of the forces driving global climate regime shifts may originate outside the Arctic, the impacts of global climate change are exacerbated in the Arctic (ACIA 2004). Temperatures in the Arctic have risen faster than in other areas of the world as evidenced by glacial retreat and melting of sea ice. A few bird species, such as black guillemot that feed near the ice edge, may not be able to bring high quality food to their young as the pack ice moves further offshore.

The increasing thickness of the active layer of soil above arctic permafrost is likely to cause changes in moisture regimes and the distribution of vegetation types over much of the Arctic in coming years. Thawing of the permafrost may result in increased amounts of surface water in some areas. Areas of permafrost with substrates composed of fine-grained materials may be susceptible to drying, erosion, and desertification (ACIA 2004). Warmer soil temperatures are likely to increase thermokarst, and increases in sea level may inundate low lying tundra areas, increasing salt marsh, aquatic and wet tundra vegetation types and erosion of coastal bluffs (ACIA 2004). Such impacts of climate change could accelerate or exacerbate changes in soil thermal regimes that occur with development, potentially leading to greater impacts to bird habitat from changes associated with thermokarst. Rising temperatures are likely to favor the expansion of the northern boreal forest into areas currently occupied by tundra. Global climate change may also result in an increase in shrubs at the expense of forbs and graminoid vegetation characteristic of Arctic tundra. In addition, rising seal levels resulting from increasing temperatures may further reduce the amount of tundra habitat available to nesting birds by causing coastal erosion and by inundating low-lying areas (Mars and Houseknecht 2007). These changes may be beneficial to some species such as those associated with boreal forest or shrub habitats, but a reduction in the amount of tundra habitat available could negatively impact tundra-nesting shorebirds and waterfowl and add to the cumulative effects of oil and gas development.

4.7.7.8.4 Contribution of Supplement Alternatives to Cumulative Effects

Impacts from ice road construction within the planning area would occur on 15,642 to 21,763 acres, while impacts from ice pads and ice airstrips would occur on another 1,126 to 1,700 acres; these impacts to bird habitat would be short-term and would not accumulate. Long-term impacts to bird habitat from seismic surveys in the planning area would occur on approximately 150 acres under all alternatives. Development in the planning area could directly impact approximately 3,270, 3,716, 4,649, and 4,378 acres, and indirectly impact 9,343, 10,178, 13,001, and 12,961 acres of bird habitat for Alternatives A through D, respectively (Table 4.2-G). These impacts would be long-term and would accumulate. Total, long-term, direct and indirect impacts to bird habitat from exploration and development combined would occur on 0.28% (Alternative A) to 0.39% (Alternative C) of the planning area. As shown on maps 3-12 to 3-18, the areas to the north, northeast, and east of Teshekpuk Lake and extending to the coastline have medium to high population densities of several species of waterfowl, and shorebirds, including white-fronted geese, brant, and pintails. Depending on the types and locations of facilities, impacts to brant and other waterfowl could accumulate, especially where species are concentrated, and affect the long-term health of local populations. The effects to waterfowl, shorebirds, and other birds from oil and gas development would be less under Alternative A and Alternative B, because all (Alternative A) or most (Alternative B) of this area would be closed to leasing under these alternatives. The effects would be greatest under Alternative C, since the entire area

would be open to leasing. The effects from Alternative D would be less than Alternative C, but greater than Alternative B, since some development could occur within this area. Impacts associated with the planning area would be additive to past, present, and reasonably foreseeable future bird impacts on the North Slope.

Development in the planning area would increase the total amount of impacts on birds and their habitats, and generally would be additive in nature. Exceptions may occur in relation to development in the Northwest NPR-A and Beaufort Sea. Depending on oil prices and where and how much oil is ultimately developed in the planning area, there could be synergistic effects on acreage of bird habitat and associated disturbance that would take place in the Northwest NPR-A. This would occur if a large discovery in the northwest part of the planning area would make economic the development of an oil field in the northeast part of Northwest NPR-A which would not otherwise have been economically developable. (See discussion of Northwest NPR-A under **section 4.7.3.3**). This potential scenario is least likely under Alternative A because less acreage in the northwest portion of the planning area would be made available to leasing under this than the other three alternatives.

Synergism could similarly result if development north of Teshekpuk Lake resulted in offshore development being more economically feasible. Such offshore development would likely result in additional impacts to bird from developments built onshore in support of the activities offshore and from interactions of birds with offshore developments including collisions and oiling. This would most likely affect the northern portion of the planning area or the Beaufort Sea coastal portions of the Northwest NPR-A. This scenario is unlikely under Alternative A, because very little coastal area in the planning area would be available for lease and even less for surface development. It would be most likely under Alternative C, somewhat less under Alternative D because of development constraints, and less yet under Alternative B because of lands unavailable for lease.

4.7.7.8.5 Conclusion

Impacts to habitat and disturbance related impacts to birds on the North Slope from future oil and gas exploration and development are expected to be additive with respect to impacts from other past, present, and future non-oil and gas activities, from past and present oil and gas activities, and from impacts sustained along migratory routes, and in wintering areas. Impacts in the planning area would increase the total amount of bird habitat and disturbance related impacts sustained by all oil and gas development, and would be additive in nature except in the following potential cases where synergism is likely. If a large discovery is made in the northwest or northern part of the planning area, it could make additional developments in the Northwest NPR-A or offshore more economically feasible, resulting in additional habitat and disturbance related impacts in the Northwest and Northeast NPR-A and in offshore areas adjacent to the Northeast and Northwest NPR-A. This possibility is more likely under Alternative B, C or D than Alternative A. The effects of global climate change are difficult to predict, but changes in habitat structure associated with climate change would likely have a cumulative impact on bird populations. The impacts in the planning area would increase the total amount of bird habitat and disturbance related impacts by all oil and gas development, and would generally be additive in nature for the most part, except as noted above under Contribution of Supplement to Cumulative Effects.

4.7.7.9 Mammals

4.7.7.9-a Terrestrial Mammals

Onshore and offshore oil and gas exploration and development and their support activities in the planning area are the primary contributing activities in terms of cumulative effects on mammals on the North Slope. The primary effects from oil and gas exploration include habitat loss and disturbances that displace mammals from preferred habitat areas or impact their behavior. An oil spill could cause direct harm or mortality to mammals due to its toxic effects, and also affect habitat.

Other factors that contribute to the cumulative effects on mammals on the North Slope include permitted activities such as non-oil and gas-related overland moves and development, scientific data gathering, recreation, and subsistence and sport hunting. Global climate change is of concern because it may cause shifts or reductions in available habitat types, and a concurrent shift or reduction in mammal populations that use these habitats. In addition, an analysis of cumulative effects to migratory mammals cannot ignore effects to animals on migratory routes or wintering areas, where impacts of human activities and climate change could be independent of activities on the North Slope. Because mammal populations can show substantial changes between years and even over longer periods of time, it is often difficult to determine if effects are accumulating at the population level, or merely reflect short-term shifts in population numbers.

4.7.7.9-a.1 Past and Present Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development.

Non-oil and gas activities by government agencies and non-government research efforts have had minor impacts on terrestrial mammals. The amount of such non-oil and gas activity on the North Slope is relatively low, and impacts consist primarily of short-term disturbance to individual animals. Aircraft disturbance of terrestrial mammals associated with resource-inventory survey activities (particularly by helicopter traffic) would be expected to have short-term effects on some caribou, moose, muskoxen (particularly cow/calf groups) and bears, with animals being briefly displaced from feeding and resting areas when aircraft disturbances occur nearby. Unless they were to occur multiple times per day and over many days, it is not expected that these types of disturbances would have effects that persist and accumulate.

Approximately 15,800 to 25,000 caribou from four North Slope herds (Carroll 2005; Dau 2005; Lenart 2005; Stephenson 2005) are harvested annually by subsistence and sport hunters, most of whom reside and hunt outside the North Slope, including northwestern Canada. Caribou of the TLH use the planning area more than the other three herds, and the TLH is the herd most often harvested by residents of Atqasuk, Barrow, Nuiqsut and Wainwright. Based on surveys conducted in the past four years, Barrow residents harvested approximately 4,700 caribou annually, while 230, 450 and 1,200 caribou were harvested annually by residents of Atqasuk, Nuiqsut, and Wainwright, respectively (Carroll 2005; Dau 2005; Lenart 2005; Pedersen 2006). Since caribou populations on the North Slope appear healthy and are stable or increasing in numbers, except for the Porcupine Caribou Herd which has declined about 3.5% annually since 1989 (Stephenson 2005), hunter harvest is likely replacing some of the loss of animals that would occur due to natural mortality, and effects are not apparently accumulating. Moose and muskox populations on the North Slope have fluctuated dramatically over the last 15-20 years, due primarily to natural causes, and hunting regulations have varied accordingly so the effects

of hunting are not additive to natural losses. These two species represent only a small fraction of terrestrial mammal harvest on the North Slope.

Non-oil and gas development at former military sites and in villages has caused the loss of habitat and increased levels of disturbance. DEW-Line sites and other military facilities, villages, public roads, airstrips, and other non-oil and gas infrastructure have been developed using gravel pads or on bare ground cleared of vegetation. Approximately 2,500 acres (1,800 acres of village and public facilities, and 700 acres of military facilities) have been impacted, and this loss of vegetative cover is likely to persist into the indefinite future. These villages and developments are within or near important mammal use areas, including important summer, winter, and migration range for the TLH, WAH, and CAH caribou (see Maps 3-20 to 3-25). Development has led to the loss of habitat by covering tundra with gravel and increased disturbance effects to mammals through human activity in the vicinity of villages. These effects, coupled with subsistence and sport hunting pressure, have resulted in effects to caribou that persist today, i.e. the gravel and human activities remain, but are relatively minor compared to the habitat alteration and disturbance effects of the oil fields.

Oil and Gas Exploration and Development Activities

Seismic Activities and Exploration

Loss of habitat and disturbance are the two primary factors associated with seismic activities and exploration that could affect mammals on the North Slope. Until the past two decades, seismic testing resulted in few conflicts with caribou in Arctic Alaska (NRC 2003). Seismic surveys on the summer ranges of the CAH and WAH caribou were conducted during winter, when the animals were rarely present. In a few cases, winter seismic survey areas at times overlapped with CAH, TLH, WAH, and Porcupine Herd caribou winter ranges, but impacts were probably limited to small groups of animals. In the past 20 years, the intensity of seismic operations has increased in the planning area and exploration has extended into the foothills of the Brooks Range to the east of the planning area, both of which are areas where more TLH and CAH wintering caribou, respectively, are found. It is likely that these activities briefly disturbed and displaced TLH caribou near seismic grids, exploration drill sites, and along ice roads and aircraft transportation routes. However, it has been assumed that these effects did not persist after exploration was completed, and there was no consequential effect on the abundance or productivity of the caribou. This assumption has not been scientifically tested, however, and conditions for winter survival vary from year to year. It is possible that this disturbance could have an additive effect on natural winter mortality and could disproportionately impact young of the year and pregnant cows. Such an impact over several years could accumulate and reduce the productivity of the caribou herds involved.

Much of the ACP and nearly all of the planning area have undergone seismic surveys since the 1940s (see Figure 4-1). Rolligons and track vehicles used during seismic exploration have left some tracks on tundra habitats that are still visible today and could make the habitat unsuitable for some mammal species. Only a small portion of seismic and camp move trails are still in evidence (about 100 acres; Kevan et al 1995). Use of lightweight vehicles, dispersing traffic patterns, minimizing sharp turns, and requiring surveys to be done when there is adequate snow and frost cover to protect the tundra have helped to minimize damage to vegetation used by caribou (Walker 1996).

Other sources of habitat loss include exploration sites with gravel pads, disturbed areas around these pads, exploration airstrips, and gravel exploration roads. Based on a report by the NRC (2003), in 2001, approximately 1,700 acres had been impacted by these sites in the past, and

1,130 acres of disturbed areas were still evident. Most of these sites were developed before 1977, thus, their effects on the vegetative landscape have persisted for decades, and are likely to persist for several more decades. As industry has shifted towards use of ice roads and pads during exploration, loss of mammal habitat has slowed greatly. Ice roads and pads have minor effects that could impact mammal habitat for several years, but would be unlikely to accumulate.

Oil and Gas Development and Production
Loss of terrestrial mammal habitat from road and pad construction and gravel mining, and disturbance associated with development and production activities, are effects to mammals that have occurred in the past and that persist today. Peat and gravel roads, gravel pads, and gravel mines have caused the direct loss of habitat, and also have led to the indirect loss of habitat from road dust and alteration of natural drainage patterns. Through 2001, over 500 acres of peat roads still showed evidence of disturbance, even though most of these roads were constructed over 30 years ago. For the North Slope as a whole, it is expected that by 2010 gravel will have been used to construct about 9,680 acres of roads and pads in the oil fields, 332 acres of the Dalton Highway, 1900 acres will have been impacted by other oil field related disturbances, and gravel mines will have impacted another 6,430 acres (Table 4.7-H). Approximately 4,500 acres of gravel mines have been rehabilitated but only 70 acres of gravel pads (NRC 2003). However, rehabilitation of gravel mines produces primarily fisheries habitat, not the tundra vegetation that is habitat for terrestrial mammals, and rehabilitation of gravel pads has produced mixed results that have not restored areas to original conditions. Thus, total habitat loss and disturbance through 2010 is expected to amount to about 18,342 acres (Table 4.7-H).

Motorized traffic along about 400 miles of roads has disturbed, impeded the movement of, or displaced caribou and other terrestrial mammals (NRC 2003). Disturbance of caribou from road traffic associated with pipelines has been shown to cause short-term displacement of caribou within about 1 mile of the road (2 ½ miles for parturient females and calves and subsequent abandonment of some calving habitat Dau and Cameron 1986). Road traffic has delayed the successful crossing of pipelines and roads by caribou, and could have adverse energetic effects on some animals. Grizzly bears, wolves, Arctic foxes, and other mammals generally seem to cross roads more easily than caribou.

Road construction has increased access to previously undeveloped areas and has increased hunting pressure on terrestrial mammals from public and subsistence hunters in more remote regions of Alaska. Hunting pressure and harvests have increased for many wildlife species near the TAPS since its construction but have not produced adverse population effects (TAPSO 2001).

Oil development in the Prudhoe Bay-Kuparuk River Unit area has caused displacement of CAH caribou from a portion of the calving range, with a shift in calving distribution away from the oil fields (Nellemann and Cameron 1996; Lawhead 1997; Cameron et al. 2002, 2005; NRC 2003). The reduction in calving habitat use near oil development facilities could eventually limit the growth of the Arctic caribou herds within their present ranges and prevent the herds from reaching the maximum population size that they could achieve without the presence of development. It is possible that such an effect would not be apparent, however, because natural changes in the distribution and productivity of the herds would be likely to influence the abundance and growth of caribou populations over and above the effect of reduced habitat use caused by cumulative oil development. For example, the CAH caribou population estimate decreased from 23,000 in 1992 to 18,100 animals in 1995, and then rose to 31,857 caribou in

2002. However, recent information on the body weights of CAH cow caribou (and their calves) that calve west of the Sagavanirktok River, compared with CAH cow caribou and calves from calving grounds east of the river, suggested that disturbance displacement of cow caribou may be affecting CAH caribou productivity (Cameron 1994; Nellemann and Cameron 1996; Cameron et al. 2002, 2005; Arthur and Del Vecchio 2006). On the other hand, differences in densities and movements between segments of the CAH caribou on the oil fields and east of the fields may have contributed to the decline (Cronin et al. 1997). The NRC (2003) suggested that the combined effects of industrial activity and infrastructure, and the stress imposed by insects, might have contributed to the reduction in size of the herd seen from 1992 through 1995. Cronin et al. (2000) argued that population-level impacts from oil field development have not occurred for this herd. However, comparing the higher growth rate of the TLH to the growth rate of the CAH, Griffith et al. (2002) and Cameron et al. (2005) suggested that the CAH might have been influenced by development infrastructure after 1987.

The alteration of over 17,000 acres of tundra habitat in the Prudhoe Bay area may have the potential to effect the distribution and abundance of terrestrial mammals other than caribou (e.g. muskoxen; Garner and Reynolds 1986; Clough et al. 1987), but such effects have not been observed (bears; Shideler and Hectel 2000) with the possible exception of Arctic foxes, which apparently have increased in numbers near the oil fields (Burgess et al. 1993). Muskox have continued to expand their range westward across the North Slope from an introduced population in the Arctic National Wildlife Refuge (but have declined due to increased predation in recent years). There have been no apparent effects on wolves or other terrestrial mammal populations associated with this development.

Spills

The NRC's Committee on Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope found that most spills to date have had only local effects, and that there is no evidence that effects of spills have accumulated (NRC 2003).

Summary of Past and Present Effects and Their Accumulation

Approximately 2,500 acres of habitat have been directly impacted by non-oil and gas development and those impacts continue to persist. Oil and gas activities have caused an additional habitat loss or alteration of over 18,000 acres that persist today. Since most of these impacts are associated with ongoing residential and non-oil and gas commercial development, or oil and gas activities, these impacts to habitat are additive to future impacts and would be likely to persist for several decades or more in the absence of an active reclamation program. Oil and gas development has altered the distribution of female caribou during the calving season and interfered with caribou movements between inland feeding areas and coastal insect-relief areas. Female caribou may also experience lower parturition rates when in close proximity to oil field development. It has also been suggested that declines in CAH caribou productivity in the early 1990s may have been the result of additive effects of oil field development and high insect activity, although populations of TLH, CAH, and WAH caribou have steadily increased since the mid-1970s. Thus, disturbance of caribou due to oil field development may adversely affect caribou populations, but these effects are not readily apparent based on population trends. Other mammal populations (e.g., moose, muskox, fox and grizzly bear) have been little affected, or some may even have benefited from development on the North Slope. Subsistence and recreational hunting pressure has likely increased from historic levels due to increases in human populations and better access to the North Slope. Still, based on subsistence harvest surveys, subsistence harvest of mammals was relatively stable during the 1980s and early

1990s. Based on population trends of game mammals on the North Slope, hunting does not appear to be adversely affecting mammal populations.

4.7.7.9-a.2 Future Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Non-oil and gas activities on the North Slope, including archaeological and paleontological digs, camps associated with scientific studies, recreational use, overland moves by transport vehicles, and use of OHVs such as four-wheel vehicles and snowmachines, would continue to disturb mammals and cause the loss of minor amounts of mammal habitat. In most cases, loss of habitat would be temporary, lasting only a few years. DEW-Line and other military sites, villages, airstrips, and other non-oil and gas infrastructure are likely to persist into the indefinite future, and for villages, likely to increase in size causing the loss of additional habitat. The amount of area that would be disturbed by new development on the North Slope in villages and other public facilities is projected to increase by about 2% annually, approximately doubling by 2045 when human population may level off.

Oil and Gas Exploration and Development Activities

Seismic Activities and Exploration
Based on projections developed for the planning area and extrapolated to the rest of the North Slope, seismic exploration activity could impact up to 86,400 acres of habitat annually, North Slope-wide, with 125 acres of that total still showing moderate to high levels of disturbance a decade later. Other sources of habitat loss include exploration sites with gravel pads, disturbed areas around these pads, exploration airstrips, and gravel exploration roads. These have been replaced in recent years by ice roads, airstrips, and drilling pads to reduce the costs and environmental effects of gravel construction (Johnson and Collins 1980, Hazen 1997). Impacts from ice roads and pads are short-term (Yokel et al. in press) and are not expected to accumulate. As a result, only a small amount of habitat is likely to be affected long-term by exploration activities (i.e. seismic). However, if climate warming (see below) shortens the winter season to the point where ice roads are not economically feasible for all exploration drilling, the alternatives may cause greater habitat impacts than current practices.

Oil and Gas Development and Production
Development activities that could contribute to cumulative effects to mammal habitat on the North Slope include oil and gas development, including the planning area and northwestern and southern portions of the NPR-A; Federal and state offshore oil and gas development (through the construction of supporting onshore infrastructure); state onshore oil and gas development; oil and gas transportation; and road construction. All of these activities involve construction of infrastructure that would destroy habitat within the immediate footprint of the project and indirectly affect habitat through dust, flooding, changes in natural drainage patterns, snow drifting, increased water and air pollution, and oil and chemical spills.

The increase in the amount of area disturbed by oil and gas development on the North Slope has slowed in recent years. Before 1988, the oil field road network grew by about 24 miles per year, but only 3 miles per year since 1988. The average rate of all gravel placement was about 421 acres per year before 1988, and only 42 acres per year between 1988 and 2001 (NRC 2003; Table 4.7-F). If the current rates continue into the future for areas outside the Northwest NPR-A and the Northeast NPR-A Planning Area, and the ratio of gravel mine acres to gravel footprint acres remains about 5:1 (see **section 4.2.1.2**), about 1,050 additional acres would be covered by

gravel, and 210 acres impacted by gravel mines, in the next 25 years. Approximately 6,300 acres would be indirectly affected by dust, changes in hydrology, and thermokarst. To carry these same assumptions through, another 1,260 acres of vegetation could be destroyed by gravel placement or gravel mines for oil and gas activities between 2035 and 2060, and another 6,300 acres could be indirectly impacted by development. The 42 acres per year increase since 1988 has been in an area where the main, oil field road network had already been built. There are currently no roads in the planning area or Northwest NPR-A to support oil field development. Thus per year growth in the planning area (as detailed previously for each of the four alternatives, **sections 4.3.5, 4.4.5, 4.5.5 and 4.6.5**) and Northwest NPR-A (described in the table in **section 4.7.3.3**) would have to include construction of in-field roads and would be expected to proceed at a faster rate.

Thus impacts to mammal habitat will accumulate from the following sources: past non-oil/gas activities, non-oil/gas activities from now until about 2045, past oil/gas activities outside of the planning area and Northwest NPR-A, future oil/gas activities outside of the Northeast and Northwest NPR-A up to 2060, future oil/gas activities in the Northwest NPR-A, and future activities in the planning area (Northeast NPR-A). All future impacts are additive to the impacts to habitat that have accumulated in the past and persist today, but in the context of the entire ACP and North Slope, these cumulative impacts would be relatively small. Based on direct (33,962 acres) and indirect (132,401 acres) that could still persist in 2060, direct and indirect impacts to habitat would occur on 1.3% of the ACP and 0.29% of the North Slope. These estimates do not take into account the quality of habitat that would be impacted on the North Slope. It is likely that the focus of future oil and gas exploration and development would be within the Barrow Arch, which is located in the ACP. Areas to the north and east of Teshekpuk Lake provide important calving, post-calving, and insect-relief habitat for TLH caribou (see maps 3-23 to 3-25). Thus, impacts to caribou and other mammals from development in this area would likely be much greater than if development occurred in areas that were little used by caribou. Nor do these figures take into account impacts from construction of a natural gas pipeline from the North Slope to market or burial of gas pipelines within the North Slope from new commercial gas developments. If a natural gas pipeline was built from the North Slope, approximately 23,200 acres would be disturbed during construction, about 4,800 acres of that on the North Slope. (TAPS Renewal EIS, p. 4.7-80) Because gas pipelines are likely to be buried, they are anticipated to have little long-term impacts on caribou or other terrestrial mammals.

Disturbance

Cumulative oil and gas development on the North Slope could result in a long-term displacement and/or functional loss of habitat for CAH, TLH, and WAH caribou. Future State of Alaska lease sales on the North Slope between the NPR-A and the Arctic National Wildlife Refuge, and in the foothills of the Brooks Range, would increase the amount of activity associated with oil exploration and development within the CAH caribou range. Future offshore leases in the Beaufort Sea could expose TLH and CAH caribou to additional activities related to oil and gas development (through onshore facilities to support offshore leases). Future lease sales in the NPR-A could expose a large number of the TLH caribou to exploration and development activities on their summer and winter grounds, and during migration. Animals from the WAH caribou would also be exposed to development activities in their summer range.

Development of onshore oil and gas resources in the Northwest NPR-A could result in construction of an additional aboveground pipeline that would pass through the planning area. Construction of a pipeline from the Northwest NPR-A east to the Kuparuk River Unit, or a southern pipeline route connecting to TAPS Pump Station 2, would temporarily disrupt

movements of CAH and TLH caribou. Movements of TLH and WAH caribou from wintering habitat to calving grounds could be temporarily disrupted. However, pipelines associated with lease sales under this supplement would not have associated roads, and should therefore have minimal effects on caribou movements once construction was completed. State of Alaska oil and gas leasing offshore and adjacent to the CAH and TLH caribou ranges, as well as Federal OCS leases in Harrison Bay west to Barrow, might include offshore pipelines that would come onshore within the TLH caribou range and connect with the facilities at Kuparuk. Potential offshore oil development adjacent to the TLH and CAH caribou ranges could result in increased surface vehicle traffic, which would disturb caribou along transportation corridors that would connect offshore oil discoveries with the existing infrastructure. Development also might increase disturbance of caribou by ground vehicles and air traffic in insect-relief areas along the coast, and perhaps reduce the seasonal use of coastal areas by cows and calves.

The reduction in calving habitat use near oil development facilities could eventually limit the growth of the Arctic caribou herds within their present ranges and prevent the herds from reaching the maximum population size that they could achieve without the presence of development. It is possible that such an effect would not be apparent, because natural changes in the distribution and productivity of the herds may influence the abundance and growth of caribou populations over and above the effect of reduced habitat use caused by cumulative oil development. Alternatives B, C and D would permit activities within the TLH caribou calving grounds; therefore, calving TLH caribou could be exposed to oil and gas development facilities and activities at a time of year when they are most sensitive to disturbance, possibly resulting in reduced calving success.

Oil development within the planning area could expose summering WAH caribou to noise and disturbance impacts. If development occurred in the southern part of the planning area, some WAH animals could be exposed to development activities during the insect season, and normal movement patterns could be disrupted. This herd is not currently exposed to oil and gas development activities in any other part of its primary range, but portions of the herd cross the Red Dog Mine haul road during migration. Therefore, relatively minor cumulative impacts to the WAH caribou would exist, although development in the Northwest NPR-A could increase these impacts further. These effects on TLH, CAH, and WAH caribou would accumulate with other past effects on these herds, although the likely magnitude of these effects is difficult to ascertain, especially given the increase in herd sizes that have occurred in recent years in spite of oil and gas development on the North Slope.

The alteration of over 17,000 acres of tundra habitat in the Prudhoe Bay area may have the potential to effect the distribution and abundance of terrestrial mammals other than caribou, (e.g. muskoxen; Garner and Reynolds 1986; Clough et al. 1987), but such effects have not been observed (bears; Shideler and Hectel 2000) with the possible exception of Arctic foxes, which apparently have increased in numbers near the oil fields (Burgess et al. 1993). Muskoxen have continued to expand their range westward across the North Slope from an introduced population in the Arctic National Wildlife Refuge (but have declined due to increased predation in recent years). There have been no apparent effects on wolves or other terrestrial mammal populations associated with this development.

The increase in the number of development facilities on the North Slope would be expected to increase the number of negative interactions between humans and grizzly bears, and to result in the loss of bears because of their attraction to human refuse. These interactions could eventually result in a decline in grizzly bear abundance near development areas. It is also expected that cumulative oil development on the North Slope would result in an increase in the

abundance of Arctic foxes near development areas, which could affect tundra-nesting birds and molting waterfowl and could also pose a health hazard to humans through the spread of rabies and other diseases among the growing fox population. Efforts to minimize the amount of refuse available to mammals should lead to a long-term decline in fox and other mammal populations near oil fields.

Spills

The oil industry is required to have oil spill response and clean-up capabilities, and small spills on lands or waters in the planning area or in existing or future North Slope oil fields are expected to be contained and cleaned up before substantial mammal and habitat loss can occur. In addition to mortality through direct contact with oil, some mortality could result through ingestion of contaminants in food and water, from the cumulative effects of the numerous small spills expected from the operation of any oil field.

The spills associated with reasonably foreseeable future projects could affect terrestrial mammals on the North Slope. Cumulative effects would depend on the number, size, location, and timing of spills, the type and effectiveness of the oil spill response, and the species and population of terrestrial mammals exposed to the spill. Potential oil spills from both offshore and onshore oil activities associated with Federal and state leases would be likely to have a small effect on terrestrial mammals because comparatively low numbers of animals would be expected to be disturbed or contaminated, or to ingest contaminated food sources and die as a result. Spills would have mostly sublethal effects on terrestrial mammals and would impact only a very minor percentage of the available habitat. The greatest potential for impact to terrestrial mammals would be through disturbance impacts during response, cleanup, and rehabilitation.

The amount of oil produced on the North Slope under the reasonably foreseeable future scenario is likely to continue to trend downward. As oil production slows, coupled with improvement in spill prevention and control technologies and training, the potential for effects to mammals should decline over time. This trend could be countered, however, by an aging pipeline system if that should lead to an increase in pipeline leaks.

Abandonment

Abandoned gravel pads and roads could provide some benefits as insect-relief sites for caribou, and provide special habitat for burrowing species, such as Arctic ground squirrels and other mammals. The ultimate fate of the gravel pads and roads would not be known until closer to end of the production field life. Permitting agencies could require that gravel be removed, in part or total, and the tundra revegetated. If other uses are determined by the permitting agencies to be preferable, the agencies could allow the permittee to leave the gravel pads in place, either revegetated or not revegetated. Removed gravel either would be disposed of or reused for another development.

Abandonment of airstrips could occur in conjunction with abandonment of pads. The gravel airstrips would be managed in a similar manner, depending on the decisions made by land managers and permitting agencies at the time of abandonment. Gravel airstrips would either be removed and the tundra revegetated, the gravel revegetated but otherwise left in place, or left in place and maintained for public use.

Summer road and air traffic generated by abandonment and rehabilitation activities could cause disturbance, displacement, and mortality to caribou and other mammals that would be similar to, and at the same levels as that caused by traffic during construction and greater than that during normal field operations. If pads, roads, and airstrips were revegetated without removing the gravel, the habitat would not return to its current utility in the foreseeable future. If gravel was removed, habitat similar to that currently existing in the area could be created and used by mammals, though it would still take decades for recovery and the precise mix of habitat types would likely not be the same as what prevailed at the time of disturbance. The effects of habitat loss would accumulate, as described above, to the extent that habitats were not, or could not be, restored to their original condition.

4.7.7.9-a.3 Global Climate Change

Temperatures in Alaska, and throughout the Arctic, are thought to have fluctuated considerably over the last few centuries (Mann et al. 1999). Despite this fluctuation, the last 100 years appear to have been the warmest century in the last 400 years (Overpeck et al. 1997; IPCC 2001; ACIA 2004). As predicted by global climate models, Alaska's surface air temperature has warmed throughout much of the state since at least the mid-1970s (IPCC 2001, ACIA 2004). Continued warming of the climate could have major effects on the ecosystems of Alaska, particularly the North Slope. However, the large amount of natural variation inherent in the system limits our current understanding of the consequences of climate change. This and the complexity of tundra ecosystems make predicting the effects of climate change on terrestrial mammals difficult.

It has been predicted that an increase in abundance of deciduous shrubs, especially birch (less favorable caribou forage), and a decline in the abundance of grasses-sedges such as tussock cottongrass (an especially important food of calving caribou), would occur if temperatures in the Arctic were to increase, thereby reducing the amount of available forage for caribou on the North Slope (Anderson and Weller 1996). Other studies have predicted shifts in the composition of Arctic tundra, not only toward increased shrub height and cover extent (Chapin et al. 1995; Sturm et al. 2001; Walker et al. 2006), but also increased grass and sedge species. These increases would likely be at the expense of lichen (an important caribou winter forage) and moss cover (Chapin et al. 1995; Cornelissen et al. 2001; Jorgenson and Buchholtz 2003; Epstein et al. 2004; Walker et al. 2006). Indeed, these changes have already been observed to some extent on the North Slope. Over decades, warming temperatures could even result in the invasion of tundra habitat by taiga woody plants (taiga forests; Starfield and Chapin 1996), a less favorable habitat for tundra mammals, thereby potentially affecting their populations. Warmer temperatures could also result in increased insect abundance and periods of activity (NRC 2003), which could reduce caribou productivity. Alternatively, predicted weather patterns may result in changes to predominant wind direction and increasing wind strength, thus suppressing insect flight. Changes in weather patterns could alter caribou movements and distribution. Calving grounds could shift in response to changes in vegetation. Insect-relief habitat could become increasingly important, because of increased insect abundance and activity. Coastal erosion and the inundation of low-lying areas along the coast due to increases in sea level may alter the availability and extent of insect-relief areas and may cause shifts in the usage of particular areas. Over time, areas that are currently closed to leasing could become less important to caribou, while areas that are open to leasing could become more important.

The ACIA (2004) noted that the Porcupine Caribou Herd, which is the largest migratory herd of mammals shared between the U.S. and Canada, has declined about 3.5% annually since 1989, possibly due to climatic effects. However, during this same period, the WAH, CAH, and TLH

caribou populations have trended upward. A warming trend would stimulate faster plant growth in the spring, which should result in higher calf growth rate and allow cows to replenish fat reserves sooner. However, warmer springs have caused the Porcupine River to thaw earlier in spring. Historically, the herd crossed the river while still frozen to access calving grounds in the Arctic National Wildlife Refuge. With the river thawing earlier, cows that calve early must try cross the flowing river with their calves, causing thousands of calves to wash down the river and die (ACIA 2004).

The only certainty with climate change is the uncertainty regarding just what will eventually occur. Predictions generally suggest that future conditions on the North Slope will be less favorable to arctic adapted species, such as muskoxen, caribou and arctic fox, and perhaps more favorable to boreal adapted species such as moose and red fox. The effects of climate change on mammal populations could in many cases be additive to those effects of oil and gas exploration and development. Any change, positive or negative, may impact terrestrial mammal species. While one species may benefit, another may be secondarily impacted, e.g. an increase in population of a predator may result in additional predation on a prey species.

4.7.7.9-a.4 Contribution of Supplement Alternatives to Cumulative Effects

Impacts from ice road construction would occur on 15,642 to 21,763 acres during the life of the plan, while impacts from ice pads and ice airstrips would occur on another 1,126 to 1,700 acres; these impacts to habitat would be short-term and would not accumulate. Long-term impacts to habitat from seismic surveys in the planning area would occur on approximately 150 acres under all alternatives. Development in the planning area could directly impact approximately 3,270, 3,716, 4,649, and 4,378 acres, and indirectly impact 9,343, 10,178, 13,001, and 12,961 acres of vegetation (mammal habitat) for Alternatives A through D, respectively. These impacts would be long-term and would accumulate. Total, long-term, direct and indirect impacts to vegetation from exploration and development combined would occur on 0.28% (Alternative A) to 0.39% (Alternative C) of the planning area. These habitat losses would account for 3 to 14% of the habitat projected to be lost due to development on the North Slope during the next 50 years. Given that the area most likely to be developed under the action alternatives is located north and northeast of Teshekpuk Lake, areas that provide critical habitat for TLH caribou, impacts to caribou, and perhaps other mammals, and their habitats could be much greater than predicted based solely on amount of area disturbed. As shown on maps 3-23 to 3-25, the area to the north, northeast, and east of Teshekpuk Lake and to the coastline provides important caribou calving and insect-relief habitat. Because of its importance, Lease Stipulations K-9 and K-10 were developed for Alternative D to provide special RSO protection to caribou habitat. Lease Stipulation K-11 would limit development in the Goose Molting Area (which includes important caribou habitat) to the north of the lake. Still, caribou and other wildlife would be exposed to oil and gas disturbance in their calving, summer, and potentially winter, ranges. Depending on the types and locations of facilities, impacts to caribou and other mammals could accumulate, especially where species are concentrated such as calving grounds and insect relief areas, and could affect the long-term health of the local population. The effects to caribou and other mammals from oil and gas development would be less under Alternative A and perhaps intermediate under Alternative B, because all (Alternative A) or most (Alternative B) of this area would be closed to leasing under these alternatives. The effects would be greatest under Alternative C, since the entire area would be open to leasing with fewer mitigations than under Alternative D. The effects from Alternative D would potentially be less than Alternative C due to the intent of the extra surface occupancy restrictions, but greater than Alternative B since some development could occur within this area. Offshore development associated with leases in the Beaufort Sea could impact relatively small areas along the coast for staging and storage of

materials (e.g. one or more staging bases approximately 50 acres each in size), but is unlikely to impact large areas of habitat (e.g. the roughly 400,000 acres north and east of Teshekpuk Lake).

Impacts to vegetation (mammal habitat) and direct disturbance of mammals on the North Slope from future oil and gas exploration and development are expected to be additive with respect to impacts from other past, present, and future non-oil and gas activities and past and present oil and gas activities. The impacts in the planning area would increase the total level of disturbance and the amount of habitat impacted by all oil and gas development, and would be additive in nature for the most part. However, depending on oil prices and where and how much oil is ultimately developed in the planning area, there could be synergistic effects on acreage of habitat affected and levels of disturbance to mammals in the Northwest NPR-A. This would occur if a large discovery in the northwest part of the planning area would make economic the development of an oil field in the northeast part of Northwest NPR-A which would not otherwise have been economically developable. (See discussion of Northwest NPR-A under **section 4.7.3.3**). Such a discovery and development in the Northeast NPR-A could result in additional development in Northwest NPR-A in an area that is important insect relief habitat for the TLH. This potential scenario is least likely under Alternative A because less acreage in the northwest portion of the planning area would be made available to leasing under this than the other three alternatives.

Synergism affecting primarily the TLH through effects in insect relief habitat, but potentially other mammal species as well, could similarly result if development north of Teshekpuk Lake resulted in offshore development being more economically feasible. Such offshore development would likely result in additional habitat impacts from developments built onshore in support of the activities offshore. This would most likely affect the northern portion of the planning area or the Beaufort Sea coastal portions of the Northwest NPR-A. This scenario is unlikely under Alternative A, because very little coastal area in the planning area would be available for lease and even less for surface development. It would be most likely under Alternative C, somewhat less under Alternative D because of development constraints, and less yet under Alternative B because of lands unavailable for lease.

4.7.7.9-a.5 Conclusion

Cumulative oil development in the Prudhoe Bay-Kuparuk area encompasses more than 500 square miles, and hundreds of miles of gravel roads cross a large portion of the CAH calving range. By 2010, it is expected that more than 18,000 acres of habitat will have been destroyed or altered where roads, gravel pads, gravel quarries, pipelines, pump stations, and other facilities are located on the North Slope, and an additional 3,270 to 4,649 acres are expected to be directly affected and 9,343 to 13,001 acres indirectly affected by reasonably foreseeable development in the Northeast NPR-A. An additional 4,740 acres elsewhere on the North Slope could be directly affected and 17,100 acres indirectly affected by construction of infrastructure associated with reasonably foreseeable future development on the North Slope over the next 50 years. All of this vegetation represents habitat for mammals to one extent or another.

Cumulative effects on caribou distribution and abundance are likely to be long term, lasting as long as the life of the oil and gas fields. Any reduction in calving and summer habitat use by cows and calves as a result of future onshore leasing would represent a functional loss of habitat that accumulates and could result in long-term effects on the caribou herds' productivity and abundance. These impacts would likely be greatest under Alternative C and lowest under Alternative A. However, this potential effect might not be measurable, given the great natural variability in the caribou population productivity. The effects of oil and gas activities in the

NPR-A would be greatest on those herds that use the planning area (large numbers of TLH and smaller numbers of WAH and CAH caribou). If global climate change over the next several decades were to result in widespread changes in vegetation and insect abundance, effects of oil and gas activities to terrestrial mammals could be exacerbated through the additive effects of oil and gas activities, and could extend beyond the life of the oil fields. If these cumulative effects were to result in reductions in caribou populations, there could also be a reduction in the abundance of predators such as wolves, bears, and wolverines.

These impacts to caribou, and perhaps their mammalian predators, from activities in the planning area are expected to be additive to those from other activities except in the following potential cases where synergism is likely. If a large discovery is made in the northwest or northern part of the planning area, it could make additional developments in the Northwest NPR-A or offshore more economically feasible, resulting in even more habitat and disturbance impacts in the Northwest and Northeast NPR-A, and especially in areas critical for insect-relief by caribou. This possibility is more likely under Alternative B, C or D than Alternative A.

4.7.7.9-b. Marine Mammals

This section discusses the cumulative effects on ringed, bearded, and spotted seals, walruses, and beluga and gray whales from North Slope onshore and offshore oil and gas leasing and development activities. Current and proposed development activities could also affect other marine mammals whose ranges are located within oil tanker routes in the Bering Sea and Gulf of Alaska originating from the TAPS terminal in Valdez; the potential direct and cumulative effects of operation on marine mammal populations located along these tanker routes are discussed elsewhere (USDOI BLM 1998b; USDOI 2002; USDOI MMS 2002). The evaluations of potential impacts presented in the documents referenced above indicate that routine operations should have minimal and generally un-measurable impacts on marine mammals and that the most significant threat to marine mammals is an unlikely large spill. Further the total volume of tanker traffic is expected to decline from historic levels as North Slope production declines, resulting in reduced spill likelihood (USDOI BLM 2002a). Because tanker traffic associated with TAPS operation has been determined to have negligible effects on marine mammals those negligible effects are expected to further decline with reduced traffic, and since the majority of effects that the alternatives addressed in this documents have or would have are expected to accumulate in the northern Chukchi and Beaufort Sea, while tanker traffic would occur within the Gulf of Alaska and Pacific Ocean thus potential effects would generally be expected to occur to different individuals/populations, tanker operations associated with TAPS are not expected to accumulate in a measurable manner with North Slope operations and is therefore not included in the cumulative effects discussions below.

This section intends to describe the incremental effects of the four alternatives when combined with the past, present, and reasonably foreseeable actions that will also act upon the resource. For impacts to accumulate they must persist through time, either through the extent of their temporal distribution, or because the magnitude (intensity and spatial scale) is sufficient to affect populations for long after the disturbance has ceased or some combination of both.

The geographic scale of this analysis is species and population dependent; most ice seals do not undergo the long distance migrations of the beluga or gray whales and cumulative effects would only accrue within the Beaufort Sea area. Therefore while vessel activity moving through the Chukchi to the Beaufort may effect seals in both areas, seals in the Beaufort are not likely to be effected by activities in the Chukchi and vice versa. Beluga, gray whales, and the other less

common marine mammal visitors (e.g. harbour porpoise, killer whales) may be affected by activities occurring in the Chukchi, the Beaufort, and possibly the northern Bering Seas.

4.7.7.9-b.1 Past and Present Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Commercial fisheries compete with seals and beluga whales for prey species, and seals and whales have suffered mortality from entanglement in fishing nets. In addition, marine mammals thought to be raiding fishing nets have been shot by fishermen. Marine mammals have also been displaced from preferred feeding habitats by noise and visual disturbances caused by fishing activities. Given the low level of commercial fisheries that occur in the Beaufort and Chukchi Seas, these impacts are unlikely to have accumulated among ice seals of the Beaufort. The other long-distance migrant species, uncommon visitors may have been impacted by historic commercial fisheries but if those impacts affected populations likely to enter the Beaufort is unknown.

Little is known about the number of ringed seals harvested for subsistence, but they are an important resource to indigenous people throughout the Arctic (Smith et al. 1991). Alaska Native dependence on, and interest in, hunting marine mammals is influenced by many factors, including cultural involvement, employment, community wealth, logistics, and ice and weather conditions. The number of animals killed by hunters can be expected to vary accordingly. However, current legal restrictions should prevent harm to populations of these animals if they are properly enforced.

Grey whales were heavily impacted by commercial whaling and were one of the first species to be placed on the Endangered Species List (Department of the Interior Bureau of Sport Fisheries and Wildlife Fish and Wildlife Service 1970). The Eastern North Pacific stock was removed from the list in 1994 (NOAA-National Marine Fisheries Service 1994) and continues to increase in numbers (Angliss and Outlaw 2005). Commercial fisheries, ship collisions, and harvest continue to kill and injure grey whales; however, the number killed has not prevented the population from increasing (Angliss and Outlaw 2005).

Oil and Gas Exploration and Development Activities

Seismic Activities and Exploration

Seismic activity has been conducted in the past and in 2006 in the Beaufort and Chukchi. Although off-shore seismic activity may impact individuals and will cause avoidance behaviors in marine mammals, MMS determined that these effects would not persist through time or result in population number or distribution changes (USDOI MMS 2006). Although all these ongoing actions may result in mortality to a few individuals each year, and cause disturbance effects to a larger number, they do appear to result in the accumulation of effects that alter population structure or distribution.

Oil and Gas Development and Production

Gravel placement for construction of drilling and production islands, offshore platforms, drilling ships, and installation of buried pipelines are sources of past habitat alteration. Only Northstar Endicott, Endicott Causeway and West Dock are still active marine gravel structures, although other artificial islands were constructed for exploratory drilling. Northstar is founded on an

abandoned exploration pad. Gravel placement for island construction has covered relatively small areas of benthic habitat, which are considered to be permanently lost. Installation of subsea pipelines may have caused short-term effects to benthic habitats but they likely persisted for less than one year. In general, marine mammals have large territories and are not dependent on local food sources, therefore the effects of habitat loss to marine mammals due to offshore oil and gas leasing and production probably have not accumulated.

Gravel islands and platforms could have or be causing localized effects on ice movements and formation around these structures, but this is not believed to have affected the distribution of marine mammals. Naturally occurring variations in ice formation and movement would have a much greater effect on marine mammal distribution than localized changes near gravel islands and platforms. Noise and construction or other activities near gravel islands and platforms are more likely to have caused disturbances that would affect a small number of marine mammals near these sites. The effects of these disturbances are generally unknown but would be persistent as long as the operation continued. Once operation ceased, avoidance behavior likely stopped or substantially decreased, thus past disturbance effects are not expected to have accumulated.

Effects of Noise and Disturbance

Noise from fixed-wing and helicopter aircraft traffic displaces marine mammals, but animals likely return shortly after the passage of the aircraft (Richardson et al. 1995). Some animals would be unaffected by aircraft traffic or become habituated to this activity. Disturbance from vessel traffic could elicit greater responses from marine mammals because the duration of the disturbance would be greater than that caused by aircraft. Whether these effects have or do accumulate is unknown, changes in long term distribution or behavior has not been recorded. While it is possible that disturbance events have resulted in chronic impacts reducing survival or reproductive success, there is no evidence to suggest that population level responses have accumulated, but it should be noted that effective inventory and monitoring of most northern marine mammals is technically and logistically very difficult and relatively small changes could have gone undetected or been masked by environmental factors.

Beluga and gray whales could have been affected by noise associated with the construction of gravel islands and drilling activities on gravel islands. However, since the migration corridor for most beluga is far offshore, few whales have likely been affected. Much of this noise occurs during the winter and would not affect whales in their wintering areas. Some whales migrating close to gravel islands may have been deflected by noise disturbances (Richardson et al. 1995; Richardson and Williams 2003; NRC 2003). Noise associated with vessel traffic could have a greater effect on migrating whales than noise from other industrial sources, and noise associated with seismic exploration could have a greater effect on migrating whales than that of other types of vessel traffic. Construction of subsea pipelines from gravel islands to the mainland would occur during the winter when beluga and gray whales are on wintering grounds. If additional staging areas along the Northeast NPR-A coast led to increased offshore activities, the potential for marine mammals to be impacted by noise or other activities would likely increase. Staging areas for the NPR-A may also increase potential for new offshore developments that could increase the amount of noise and other activities that could impact marine mammals.

Studies of the potential effects of disturbance on shore-fast ice on pupping ringed seals have showed that there was probably some displacement of ringed seals from areas close to artificial islands in the central Beaufort Sea (Frost and Lowry 1988), and that there was a higher

abandonment rate of seal breathing holes close to seismic survey lines (Kelly et al. 1988). Noise likely affected haul out behavior of pinnipeds but no quantitative data are available. From data collected in the central Beaufort Sea from 1985 to 1987, Frost et al. (1988) concluded that there were no broad-scale effects of industrial activity on ringed seals that could be measured by aerial surveys, but they also noted that there was little offshore activity during those years. Subsequent industry-funded monitoring studies for the Northstar and Liberty projects suggested minor effects on ringed seals from ice road construction and seismic exploration (Harris et al. 2001; Richardson and Williams 2000). Construction and operation of Northstar do not appear to have affected densities of ringed seals, although other activities such as shallow water hazard analysis and on-ice seismic may have influenced distribution the following year (Moulton et al. 2005).

Oil Spills

There have been no large spills (≥1,000 bbls) off-shore in the Beaufort Sea (NRC 2003). The NRC's Committee on Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope (2003) found that most on-shore spills to date have had only local effects, and that there is no evidence that effects of spills have accumulated. No on-shore spills have been reported to reach the marine environment.

Effects of Hazardous Material

Solid and liquid hazardous materials associated with Department of Defense and oil industry activities have been discarded or dumped at various locations on the North Slope, including the NPR-A. Many of these sites have been cleaned up, but low levels of hydrocarbons and pesticides remain at some sites. These localized sites probably do not represent a substantial threat to marine mammal populations, but effects likely still persist.

Summary of Past and Present Effects and Their Accumulation

Industrial activity in marine waters of the Beaufort Sea has been limited and sporadic and has likely not caused substantial cumulative effects on marine mammals. Activities in the Chukchi have been even less intensive and are unlikely to have resulted in measurable or persistent effects. However, noise and other disturbances may have displaced whales from preferred habitats in the past, although these effects are difficult to quantify and to determine if they accumulate. Commercial fisheries, shipping, and subsistence hunting are the only activities resulting in known mortalities to marine mammals; however, the combination of education, gear regulation, and good management practices appear to have prevented the effects of these mortalities from having significant effects on the populations and for those species with good population estimates (i.e., gray whale) populations have been increasing.

4.7.7.9-b.2 Future Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Commercial fisheries would continue to compete with seals and beluga whales for prey species, and seals and whales would continue to suffer mortality from entanglement in fishing nets. In addition, marine mammals thought to be raiding fishing nets may be shot by fishermen. Marine mammals may also be displaced from preferred feeding habitats by noise and visual disturbances caused by fishing activities.

Commercial fisheries on the North Slope are generally small operations that are likely to affect only a small number of marine mammals. The commercial fishing industry in the northern Bering Sea, which is growing in size, could impact North Slope seals, walruses, and beluga and gray whales wintering in this area. The extent of the impacts would depend on the level that fishing industry activities increased and their effects on the availability of prey species for these marine mammals. Prey species of seals and beluga whales, such as fish, could be directly impacted by the fishing industry, while benthic invertebrates that serve as prey for walruses could be indirectly impacted during trawling operations. Increased commercial fishing activities could also increase the potential for direct morality of marine mammals due to shooting, or displacement from preferred feeding habitats as a result of disturbance.

The Marine Mammal Protection Act allows the secretary of commerce to permit industrial operations (including oil and gas exploration and development) to take small numbers of marine mammals, provided that doing so has a negligible effect on the species and will not reduce the availability of the species for subsistence use by Alaska Natives. Regulations governing the permits identify permissible methods, means to minimize harm, and requirements for monitoring and reporting. The permits have been used to minimize the effects of on-ice activities on pupping ringed seals, to require planning and personnel training that minimize conflicts with polar bears, and to provide buffer zones around known polar bear maternal den sites. Annual surveys are conducted of subsistence resources to monitor population trends. If species populations are monitored and carefully managed, effects to marine mammal populations should not accumulate.

Oil and Gas Exploration and Development Activities

Seismic Activities and Exploration

Seismic activities are expected to continue in both the Chukchi and Beaufort Sea (USDOI MMS 2006). Analysis conducted for leasing sales in these areas and to permit seismic activity indicate that while impacts are expected they are not expected to cause population level impacts or long-term area abandonment (USDOI MMS 2003; 2004; 2006; 2006; 2006). Groups of seals and other marine mammals may be impacted each year. However, the disturbance effects are expected to be transitory and unlikely to persist through time. Since seismic activities would target different areas each year, seal and other marine mammal losses in a particular area would likely recover within a year or two and effects would be unlikely to accumulate.

Oil and Gas Development and Production

Future activity would occur in the Beaufort Sea from Barrow to Flaxman Island, and possibly to the Canadian border. Onshore development is expected to occur within the Northwest NPR-A, east of Prudhoe at Liberty, through continued development of the Alpine Satellite Fields. These onshore developments and other potential developments that may occur farther into the future, including possible construction of a commercial gas pipeline, are likely to result in additional vessel and aircraft traffic. Vessel traffic would be intermittent with large sea-lifts only occurring to support development of the CPFs. Aircraft traffic is expected to occur over land or in close proximity to the coast.

Activity in the Chukchi would occur in the off-shore of northwestern Alaska from Point Hope to Barrow (USDOI MMS 2006). Beaufort Sea development activity is expected to occur mostly near shore, adjacent to onshore oil reserves, and development would entail methods and structures similar to those currently in use (gravel islands or bottom-founded structures,

horizontal drilling, buried pipelines, and an emphasis on working during winter). Chukchi Sea development is expected to be off-shore on bottom-founded structures. The potential effects of development in these areas is described in the leasing EIS documents for the proposed Chukchi Sea Lease 193 (USDOI MMS 2006) and the Beaufort Sea lease 186, 195, and 202 (USDOI MMS 2003) as well as the subsequent Environmental Assessments for the 195 and 202 sales (USDOI MMS 2004; 2006). These documents are incorporated by reference and the expected impacts to marine mammals are summarized below.

Beaufort

The potential effects of lease sales 186, 195, and 202 are expected to be additive to existing development and other activities. MMS determined that the effects of any development resulting from the lease sales would have non-significant impacts with the exception of the occurrence of a very unlikely large oil spill. Likely impacts include noise, and aircraft and vessel traffic, and loss of a small amount of benthic habitat from bottom founded structures. Habitat surrounding any structure may be altered and no longer be suitable; however the relative extent of these impacts is expected to be small. Displacement and short-term behavioral changes as a result exploration, development and operation are expected to occur. Development resulting from these leases would increase vessel traffic, increasing the potential for collisions, primarily with large whales. Some direct and indirect mortality (through loss of reproduction) is expected but not expected to impact populations and recovery is expected to take up to one year (USDOI MMS 2003; pages IV-24-25).

Chukchi

No preferred alternative has been chosen for Chukchi Sea Planning Area; however, similar to the Beaufort Lease Sales, the action alternatives are expected to have non-significant, transient effects on marine mammals – with the exception of the effects of large or very large oil spills. Animals are expected to be displaced or undergo short-term avoidance and behavioral changes as the result disturbance associated with exploration, development, and operation. A small amount of benthic habitat would be lost to bottom-founded structures. Habitat surrounding any structure may be altered and no longer be suitable; however the relative extent of these impacts is expected to be small Development resulting from these leases would increase vessel traffic, increasing the potential for collisions, primarily with large whales. Activity in the Chukchi is more likely to affect walrus and gray whale than development in the Beaufort. Some direct and indirect mortality (through loss of reproduction) is expected but not expected to impact populations and recovery is expected to take up to one year (USDOI MMS 2006).

Oil Spills

An offshore spill would have a greater potential to affect marine mammal species than an onshore spill, although an onshore spill that spread to coastal habitats could affect small numbers of seals. An offshore spill could affect beluga whales, gray whales, seals, and walruses, particularly at the edge of the shorefast ice, which is an important habitat for marine mammals. The potential impacts to marine mammals from an offshore oil spill would depend on the location and amount of oil spilled, and the time of year. An offshore spill during the open-water season could have the potential to spread to a large area by the action of wind and currents, and could impact more marine mammals than a localized spill from an onshore source near the coast. A winter spill could affect small numbers of adult ringed seals and their pups. The effects of a winter spill could extend into the summer season if oil spill clean-up operations of a winter spill were not adequate to remove the majority of the spilled oil. Oil spilled during periods of

broken ice is difficult to clean up and could persist for longer periods in the environment. In general, the likelihood of an oil spill is low, and marine mammal populations affected by an oil spill would likely recover within one generation. However, increased development of offshore leases, coupled with exploration and development in the NPR-A and ongoing development at Alpine, Northstar, Prudhoe Bay and Point Thomson, increases the risks of oil spills that could impact marine mammals in the area.

MMS analyzed the potential for large (≥1,000 barrels) and very large (≥150,000 barrels) offshore spills resulting from lease sales in the Beaufort and Chukchi Seas. Large oil spills are considered "unlikely" and a very large oil spill "extremely unlikely" (USDOI MMS 2003; 2006). The effects of a large spill on marine mammals are expected to include mortality; however, numbers of marine mammals impacted are expected to be relatively low compared to overall population numbers. Although impacts to benthos and fisheries are also expected to occur the effects are expected to be contained within a relatively small area. Impacts are expected to last for several years, but not to persist longer than one generation for marine mammals.

A very large spill would likely contact a greater number of animals with resulting increased mortality. Population impacts would occur and could persist for 15 years or longer (USDOI MMS 2003) pages IV-238-39). Ultimately, should a large or very large oil spill occur the magnitude of its effects will be dependent on when and where the spill occurs.

4.7.7.9-b.3 Global Climate Change

Studies in recent years have indicated a general global climate change trend that has caused a reduction in the extent and thickness of the total Arctic sea ice coverage (Overpeck et al. 2005). Modeling efforts to estimate the spatial and temporal extent climate change on sea ice in the arctic remain highly variable; however, virtually all predict a significant reduction, if not absence of year-round sea ice in the Beaufort Sea in the next 50 to 100 years (ACIA 2005, Overpeck et al. 2005). Potential effects of climate change on marine mammals include but are not limited to:

- Increased noise and disturbance related to increased shipping;
- Increased interactions with commercial fisheries, including increased noise and disturbance, incidental take, and gear entanglement;
- Decreases in ice cover with the potential for resultant changes in prey-species;
- Alteration of species assemblages and interactions; and
- Changes in concentrations and distributions.

Continued reduction in sea ice coverage would be expected to change the distribution and abundance of ice seals and walruses in the Arctic (Tynan and DeMaster 1997, ACIA 2004, Derocher et al. 2004). Gray whales, killer whales, and harbour porpoise may become more common as the ice-free period increases. The potential effects of these changes on marine mammal populations are unclear, but there is speculation that a reduction in the extent of Arctic sea ice coverage could cause drastic reductions in seal and walrus populations. At a minimum, changes in the distribution and inter-species relationships of ice-associated marine mammals and cold water species more common in the Bering Sea.

Many ringed seals give birth to and care for their pups on stable shore-fast ice, and changes in the extent and stability or the timing of breakup of the ice could reduce productivity (Smith and Harwood 2001). Because of the close predator-prey relationship between polar bears and ringed

seals, decreases in ringed seal abundance can be expected to cause declines in polar bear populations (Stirling and Oritsland 1995).

4.7.7.9-b.4 Contribution of Amendment Alternatives to Cumulative Effects

Alternative A

Alternative A would minimally contribute to the cumulative effects of human activity on marine mammals. Most of the aircraft traffic associated with any development within the planning area would occur over land. No information was available to assess numerically the incremental contribution of the expected number of barge trips to support development to existing and reasonably foreseeable oil and gas development and other commercial traffic; however, the total number of additional trips is relatively small and expected to be spread out over decades. Increased ice free periods associated with climate change may increase vessel traffic but any estimate of the amount of traffic, its type or when it would begin to occur is speculative. Current vessel traffic levels may be resulting in displacement and avoidance behaviors but these are believed to be transitory and the effects do not appear to accumulate. The addition of aircraft and barge traffic of this alternative to the existing and expected traffic may result in more animals being affected more times but given the relatively short duration of responses and the expected within and between year separation of vessel disturbances, it is unlikely that the impacts would rise to population level changes. This does not mean that there is not a tolerance threshold that once passed has population level impacts. If such a threshold does exist it has not been surpassed and it is unlikely that the relatively small addition that could occur under Alternative A would be sufficient to cause the any threshold to be surpassed.

Very large marine oil spills have the greatest potential to have significant effects on marine mammals; however, both MMS and BLM consider such events to be highly unlikely. The likelihood of two such events happening in close enough temporal proximity to each other to accumulate is extremely unlikely.

Alternative B

Alternative B adds marginally to disturbance factors (aircraft and shipping) as well as the potential for very large oil spills compared to Alternative A. Alternative B would open much of the northwest portion of the planning area to leasing, as would Alternatives C and D. Infrastructure such as pipelines and CPFs developed in this area would make oil and gas development in the adjacent northeast portion of Northwest NPR-A and Beaufort Sea more likely in the foreseeable future. The additional effects of any such development in Northwest NPR-A on marine mammals would be minimal and difficult to discern from existing effects already analyzed; however if development in the planning area facilitated Beaufort Sea development than it would become more likely that the impacts anticipated in the Beaufort Sea NEPA documents would occur (USDOI MMS 2003, 2004, 2006).

It is unlikely that the additional contribution of effects under Alternative B would significantly alter the overall cumulative effects assessment summarized for Alternative A. Short-term displacement and behavioral changes would be expected. Very large oil spills in or reaching the off-shore environment remain the greatest threat to marine mammals, but the likelihood is not significantly increased under this alternative compared to Alternative A.

Alternative C

Alternative C's incremental contribution to cumulative effects on marine mammals is slightly higher than under Alternative B, but remains relatively small compared to existing and reasonably foreseeable activities. With the exception of the combination of extremely unlikely very large oil spills Alternative C is not expected to result in cumulative effects that would alter population numbers or distribution.

Alternative D

Alternative D is expected to contribute to cumulative effects in a similar fashion as Alternative B. Impacts to marine mammals from development in the planning area would generally be similar under the four proposed alternatives. The increased development scenarios of Alternatives B, C and D, in comparison to Alternative A would contribute additional barge and aircraft traffic impacts and would require a greater number of coastal staging areas than the development scenario under Alternative A. If additional staging areas along the Northeast NPR-A coast led to increased offshore exploration and development activities, the potential for cumulative impacts to marine mammals by noise or other activities would increase. The potential for a spill would be expected to increase with increasing levels of exploration and development. Thus, risks to marine mammals from a spill would be greatest under Alternative C, and least under Alternative A.

4.7.7.9-b.5 Conclusion

In addition to noise and disturbance from existing oil development, seals, walruses, and beluga and gray whales could be affected by future offshore development in the Beaufort and Chukchi seas. In addition, marine mammals wintering in the northern Bering Sea could be affected by disturbance from commercial fishing activities. Subsistence hunting of marine mammals by Alaska Natives is not likely to affect marine mammals at the population level. Disturbance could result in temporary displacement from preferred feeding habitats, and some animals could be shot by fishermen. An oil spill could affect marine mammals in offshore or coastal areas, with the impacts to marine mammals depending on the location and amount of oil spilled and the time of year. The effects of future habitat alteration associated with gravel island construction, platforms or other structures related to oil development would likely be minor. The presence of small amounts of hazardous materials, including hydrocarbons and insecticides, would likely have minor effects on marine mammals. The effects of global climate change on marine mammals are unclear, but may result in more ship traffic in the Beaufort over a longer season, commercial fisheries in the Chukchi and Beaufort, and displacement and distributional changes if not population changes among marine mammals. Climate change is likely to have the greatest influence on marine mammal populations in and adjacent to the planning area; however, species resilience and resilience as well as feedback and interactions remain highly uncertain. Estimating how the incremental addition of direct human activities (disturbance, hunting and habitat alteration remains speculative but climate change by itself is likely to have significant effects on the marine mammal community of the Beaufort and Chukchi Seas.

4.7.7.10 Threatened and Endangered Species

4.7.7.10-a Bowhead Whale

4.7.7.10-a.1 Past and Present Effects and Their Accumulation

The activities most likely to affect bowhead whales are subsistence hunting, marine seismic exploration, marine exploratory drilling, ship and aircraft traffic, discharges into the water, dredging, island construction, and production drilling. To date, there have been documented effects of industrial noise resulting in avoidance behaviors. The bowhead whale population has been growing steadily for several decades, however, despite oil and gas activities occurring in the Beaufort Sea and throughout the bowhead whale's range (George et al. 2004).

The cumulative effects analysis for Bering-Chukchi-Beaufort (BCB) bowheads includes actions within their entire range but focuses on those within the Chukchi and Beaufort Seas where the whales spend the majority of their time.

Activities Not Associated With Oil and Gas Exploration and Development

Before commercial whaling, there were over 50,000 bowhead whales (estimated) in the north polar region (Woodby and Botkin 1993). Unregulated commercial whaling continued into the early 1900s, reducing the bowhead whale populations to near the point of extinction. Bowhead whales have been completely protected from commercial whaling since 1946; Eskimos have hunted "the whale" for centuries. In accordance with International Whaling Commission rules, Eskimos are legally allowed to hunt an allocated number of bowhead whales each year for food and oil.

During 1987 to 1992, Barrow whalers harvested 7 to 22 bowhead whales each year; approximately 10 whales are harvested annually (Stoker 1983, SRBA and ISER 1993). Nuiqsut whalers have had unsuccessful whaling years in the past (20 whales from 1972-1995), but their success has improved in recent years. Unsuccessful harvests were common in the 1980s, with no whales taken in 1983 to 1985, or 1988; however, in the 1990s, the only unsuccessful years were 1990 and 1994 (USDOI MMS 1996a, USACE 1998). Nuiqsut whalers harvest two to three whales annually.

Subsistence whaling continues today. In part a result of whaling quotas, the number of bowhead whales in the Beaufort-Chukchi-Bering Sea stock is estimated to exceed 10,000 (Zeh and Punt 2005), those of the eastern Canadian Arctic and of the Okhostsk Sea in far east Russia are in the hundreds. Although the number of bowhead whales has increased from depressed levels in the early 1900s, and the Chukchi Bering Beaufort Stock is approaching or at historic levels (Angliss and Outlaw 2005, Zeh and Punt 2005) the cumulative effects of commercial whaling persist today, as worldwide bowhead whale numbers are only one-fifth of numbers estimated to have occurred before commercial whaling.

Commercial fisheries (Angliss and Outlaw 2005) and shipping (George et al. 2004, Angliss and Outlaw 2005) have resulted in injuries and likely death of bowhead whales. Reported numbers per year are low and likely an underestimation because of study limitations and reporting requirements (George et al. 2004, Angliss and Outlaw 2005).

Oil and Gas Exploration and Development Activities

Seismic Studies, Exploration and Disturbance

Seismic surveys offshore in the Beaufort or Chukchi Seas began in the late 1960's, peaking in the late 1980's. Prior to 2006, the last MMS permitted seismic in the Beaufort OCS was in 2004, and 1990 in the Chukchi (USDOI MMS 2006). Approximately 100,000 miles of 2D and 3D seismic has been collected in the Beaufort and approximately 80,000 miles of 2D in the Chukchi. These estimates are a combination of over-ice and open-water seismic (USDOI MMS 2006). MMS predicted up to 4 surveys in the Beaufort and 4 in the Chukchi, but only 3 surveys were conducted in the Chukchi and one in the Beaufort (USDOI MMS 2007). While historic seismic work likely displaced bowheads and resulted avoidance behavior, no evidence is available to suggest that these effects caused measurable impacts to bowheads. Therefore no impacts are believed to have accumulated from historic seismic activities.

Marine seismic exploration produces the loudest industrial noise in the bowhead whale habitat. Some seismic surveys are conducted in winter and spring on the sea ice, but most are done in the summer-autumn open-water period. Thus, bowhead whales and seismic boats were in the same areas during the westward fall migration. In the nearshore Alaskan Beaufort Sea, nearly all the fall-migrating bowhead whales avoided an area within 12 miles of an operating vessel, and deflection of the whales began at up to 21 miles from the vessel (Richardson 1997, 1998, 1999; NMFS 2002). Noise levels received by these whales at 12 miles were 117 to 135 dB (NMFS 2002).

Offshore exploratory drilling in the Beaufort also resulted in the deflection of fall migrating bowhead whales. Bowheads were detected changing direction at between 12 and 19 miles from drilling platforms (Brewer et al. 1993; Davies 1997; Hall et al. 1994). Drilling ships appear to cause similar avoidance behavior (LGL and Greeneridge 1987).

Construction of Northstar, Endicott, and other artificial islands occurred mostly in shallow water areas in areas not regularly used by bowhead whales. However, activity at Northstar results in deflections, particularly when barges are maneuvering (Richardson and Williams 2004).

Spills

A number of small oil spills have occurred during oil and gas exploration in the Alaskan Beaufort Sea in past years. Only five spills have been greater than one barrel, and the total spill volume from drilling 52 exploration wells (1982 through 1991) was 45 barrels (USDOI MMS 2006). None of these spills are known to have affected bowhead whales and the oil has not likely persisted in the environment.

Summary of Past and Present Effects and Their Accumulation

Hunting and commercial fishing are the two primary factors that have affected bowhead whales in the past and continue today. Commercial fishing and vessel strikes have resulted in injury and probably some mortality (Angliss and Outlaw 2005) (George et al. 1994). Subsistence take has been below the Potential Biological Removal threshold determined by NOAA-Fisheries and the allowable harvest under International Whaling Commission standards (Angliss and Outlaw 2005). While these two activities have removed individuals from the population and possibly

affected population growth rates, the impact is minimal and has not altered a strong population growth trend (George et al. 2004).

Noise and disturbance associated with offshore seismic and drilling activities, and boat and barge traffic have affected whales, causing deflection and behavioral changes. The long-term effects, and likelihood of having cumulative impacts to whales, are unknown. There is no evidence that the effects of offshore activity has resulted in long-term persistent changes in behavior or reduced fitness leading to population decline. Ship traffic in support of offshore activity may have contributed to injury/death from collisions, but no records of this occurring were found.

Although bowhead whale populations have recovered from very depressed levels in the early 1900s, the current population estimate between estimated historic levels (Angliss and Outlaw 2005). It is unlikely that past and present activities have caused impacts that have accumulated and adversely affected the BCB stock of bowhead whales in a measurable manner.

4.7.7.10-a.2 Future Effects and Their Accumulation

If oil and gas activities continue in the Alaskan waters of the Beaufort Sea, the major noise would be generated with marine seismic exploration. Other significant noise would continue to be produced by exploratory and production drilling, island construction, and vessel transit. The probable consequences are diversion of animals from their normal migratory path, possibly into areas of increased ice cover, and less use of the fall migration corridor as feeding habitat.

If two or more types of disturbance occur at the same time or in the same general area, the effects could be greater than those observed from single sources. The greatest diversion would occur if two or more seismic vessels operated simultaneously with one just offshore of the other. Such a disturbing influence set across the migratory path could displace the whales seaward reduce use of the area as feeding habitat, and affect the behavior of the animals.

Activities Not Associated With Oil and Gas Exploration and Development

Non-oil and gas activities could also contribute to cumulative effects on bowhead whales. A small number of bowhead whales could be injured or killed as a result of entanglement in fishing gear or collisions with ships. It is expected that subsistence whalers from Alaska and Russia would to continue to harvest bowhead whales under a quota authorized by the International Whaling Commission. The subsistence harvest is carefully managed to prevent population level effects, and to allow the Bering-Chukchi-Beaufort Sea bowhead whale population to continue to grow. Although a few individuals would likely be killed, non-oil and gas activities are not expected to have much impact on the bowhead whale population and bowhead whale populations have increased steadily under current management (George et al. 2004, Zeh and Punt 2004).

It is possible, but uncertain, that reduced sea ice in the Beaufort and other parts of the Arctic could result in increased commercial shipping traffic. This could result in an increase in vessel collisions resulting in additional injury and mortality. The magnitude of this impact would be dependent on the actually number of vessels, their transit corridor, speed, and when they occurred in areas used by bowhead, if any such increase actually occurred.

Changes in the marine environment could also result in shifts northward of important commercial fish species. If this occurred, it is assumed that the fishing industry would follow.

Increased fishing effort in the main areas currently used by BCB bowheads would likely result in an increased rate of encounters with fishing gear, greater entanglement rates and subsequent injury, loss of fitness and mortality.

Oil and Gas Exploration and Development Activities

Noise and Disturbance

Bowhead whales could be exposed to increased disturbance as a result of exploration and development of existing leases or leases acquired in future sales, including leases in the OCS and State waters. Projects and possible lease sales in the OCS that could affect bowhead whales have been summarized in earlier documents (USDOI BLM and MMS 1998:IV.G.10; 2003:V.11; USDOI BLM 2004c:4.A.3.5), and are not repeated here. Information about the potential effects of offshore lease sales on bowhead whales has been discussed in detail in several recent documents (USDOI MMS 2003; 2004; 2006; 2006). Those documents and references therein, are included here by reference. Generally these documents state that, with the exception of a large or very large spill, the effects of offshore leasing and any subsequent development would include deflections and short-term displacement and avoidance behavior. These effects are not believed to persist from year to year and thus do not accumulate. As with other marine mammals; however, it is not known if a threshold exists relative to number of disturbance events/year or the number of disturbance events among year that would result in long-term changes in movement patterns, including shifts in foraging behavior or in access to productive forage areas.

Development of the NPR-A and elsewhere on the North Slope, and offshore leases, would result in incremental increases in vessel traffic, particularly barge traffic to supply bases and camps on the North Slope. Such increases would result in a greater likelihood for disturbance to bowhead whales, should barge traffic coincide with the fall migration of bowhead whales from Canadian waters to the Bering Sea. Impacts caused by barge traffic should be limited to temporary displacement of the migratory whales, or local, short-term changes in whale behavior.

Disturbance to migrating bowhead whales has occurred from seismic activities and offshore drilling (summarized in NRC 2003). Richardson and Williams (2004) reported a statistically significant displacement of bowhead whales from Northstar Island in 2001 when noise associated with Northstar Island was the loudest. This effect was attributed to noise from maneuvering vessels rather than from the Northstar Island project itself. The authors noted that the "southern edge of the migration corridor was slightly farther offshore at the noisiest times as compared with typical times." Results in 2002 were considered equivocal and there was no evidence of an effect in 2003. However, should boat and barge traffic along the Beaufort Sea coast increase as a result of development in the NPR-A and offshore leases, deflection of the bowhead whale migration could occur. It is unlikely that such deflection would have high impacts on individual bowhead whales or the whale population.

Aircraft (fixed-wing and helicopters) flying at altitudes greater than 1,000 feet AGL generally do not impact bowhead whales. Any impacts to bowhead whales from aircraft flying at altitudes less than 1,000 feet AGL (during takeoff and landing) would likely be localized and include minor short-term deflection or changes in behavior. Aircraft would not be expected to have much effect on individual bowhead whales or the population.

Spills

If an oil spill were to occur as a result of development and production associated with any past, present, or reasonably foreseeable future development project on the North Slope or in the Beaufort and Chukchi Sea, some bowhead whales could be impacted. However, most whales directly exposed to spilled oil would likely experience temporary, nonlethal effects from skin contact with oil, inhalation of hydrocarbon vapors, ingestion of oil-contaminated prey, baleen fouling, reduction in food resources, or temporary displacement from some feeding areas (NRC 2003). A few individuals could be killed if they were to experience prolonged exposure to freshly-spilled oil. Oil spill clean-up activities (e.g., vessel and aircraft traffic) could displace some bowhead whales, should those activities coincide with the fall migration and occur outside of Harrison Bay or other waterways within the barrier islands. Such displacement would minimize the potential for bowhead whales to be exposed to freshly-spilled oil, thereby reducing the potential for lethal effects. Impacts to bowhead whales from an oil spill are expected to be limited to short-term displacement or behavioral changes, and are not expected to have much cumulative impact on individual bowhead whale or the population. However, increasing exploration in the Beaufort and Chukchi Sea, coupled with production at Endicott and Northstar facilities, would increase the potential for a large oil spill to occur. Additional information regarding the effects of an offshore spill from development resulting from leases in the Beaufort and Chukchi sea, likelihood estimates, and other related information can be found in the leasing EISs and subsequent EAs (MMS 2003; 2006; 2006).

4.7.7.10-a.3 Global Climate Change

Climate change may affect bowheads by altering physical ocean properties, influencing distribution, density, and diversity of prey species (Tynan and DeMaster 1997, Learmonth et al. 2006). However, the magnitude of the changes are unknown, as are how prey species, and subsequently bowheads will respond.

Reduced sea ice, will increase the length of the shipping season in the Arctic. This could affect bowheads in several ways. If the increase in safe shipping season resulted in increased ship traffic, it would result in increased collision risk, increased potential for ship based contaminant spills, and increased disturbance. However if it allowed ship traffic to enter the Beaufort earlier – following spring migration, but prior to the fall westward migration, there may be less ship-whale interaction, although if this allowed vessels into the eastern Beaufort feeding areas earlier, it also may disrupt feeding in those areas.

The reduction in sea ice and potential northward movement of commercial fish species may result in greater rates of entanglements, particularly associated with the crab fishery. Current entanglement rates are relatively low (Angliss and Outlaw 2005), but whether this is due to encounter rates or bowhead avoidance is unknown.

4.7.7.10-a.4 Contribution of Supplement Alternatives to Cumulative Effects

Impacts to bowhead whales from development in the planning area would generally be similar to that discussed for marine mammals. The increased development scenarios of alternatives B and C, and D would contribute additional barge and aircraft traffic impacts and would require a greater number of coastal staging areas than the development scenario under Alternative A. However, with respect to bowheads, there is little difference among the alternatives individual contribution to the cumulative effect of all past, present and future actions. However; if under Alternatives B through D, a large discovery was made in the northwestern portion of the

planning area closed under Alternative A, that discovery could facilitate additional development in the adjacent northeast part of Northwest NPR-A which would not otherwise have been economically developable (see discussion of Northwest NPR-A under **section 4.7.3**).

Alternatives B through D, in contrast to Alternative A, makes much or all of the areas north of Teshekpuk Lake available for oil and gas leasing. If development in these areas along the Northeast NPR-A coast created necessary infrastructure, it could lead to increased offshore exploration and development activities, and the potential for cumulative impacts to bowhead whales by noise or other activities would increase. Should boat and barge traffic along the Beaufort Sea coast increase as a result of development in the NPR-A and offshore leases, greater disturbance and deflection of the bowhead whale migration could occur as the result of increased activity. It is unlikely that such deflection would have high impacts on individual bowhead whales or the whale population.

4.7.7.10-a.5 Conclusion

A few whales do or could experience sublethal or lethal effects from entanglement in fishing gear, collisions with ships, or encounters with subsistence whalers. Most activities related to oil and gas development onshore on the North Slope and in the planning area would not impact bowhead whales. There would be a periodic increase in barge traffic that would contribute to cumulative impacts to bowhead whales from underwater noise and the presence of boat traffic. Exploration and development in the Beaufort and Chukchi would also increase ship and aircraft activity. Unlike on shore development, offshore development would require annual vessel traffic and regular over water aircraft flights.

While the effects of climate change on bowheads are uncertain, changes in shipping season and timing are possible, with the most likely effect that bowheads will be exposed to additional vessel traffic in the future. Bowhead whales could display a cumulative response to activities that produce underwater noise by increasing their distance from such sources by temporarily diverting their route of travel, or by temporarily changing their behavior. In general, these impacts are expected to be minor and short term. However, as noted earlier a threshold may exist beyond which the number of behavioral changes and displacements may begin to have an effect on individual fitness. If the cumulative increase in disturbance events results in impacts to enough individuals fitness, reduced reproduction could result with consequences to the population.

The individual alternatives are relatively similar in potential for effect when considered in the cumulative sense, with the exception of development under Alternatives B through D being more likely to facilitate development in Northwest NPR-A and offshore. The most likely effect that the alternatives would contribute to is vessel aircraft traffic. Given the expected time spread in major sealifts associated with each alternative and their expected CPF number (1-2 two sea lifts every 10 years), each alternative would be expected to add a short-term pulse to vessel traffic. Current vessel trips are not believed to be having an adverse effect on the bowhead population, but the biological effects of disturbance and displacement are unknown. The cumulative vessel traffic numbers in the future are unknown as is the timing; i.e. shifts to early season transport in response to reduced ice. If traffic continues with intermittent large pulses to support major development with relatively low levels of regular background traffic to supply the industry and villages it is unlikely that significant effects will emerge. However, if a threshold exists where a certain number of trips in space or time causes disturbance/displacement which results in acute or chronic effects that decrease survival or recruitment below the level the population can maintain, significant effects would occur.

Determination of the likelihood of such effects or the existence of a threshold cannot be made with the information available. Each alternative is expected to add minimally to the total traffic volumes and each sea lift would be well spaced in time; however the potential facilitation of additional on and offshore development by Alternatives B through D increases the possibility of adverse effects but does not make them certain or likely.

A large or very large oil spill that reaches marine waters has the greatest potential to adversely impact bowhead whales and could result in other effects that are individually or additively minor becoming significant. For example, if a very large oil spill removed a substantial portion of the population, subsistence hunting and take from collisions and entanglement; currently managed at sustainable levels or very infrequent respectively could act to further depress the population. Bowhead whales that come into contact with freshly-spilled oil could suffer temporary, non-lethal effects, and a few whales could suffer lethal effects. Bowhead whales could also be displaced by oil spill clean-up activities. However, given the number of days each year that bowhead whales are expected to be migrating or feeding in the area that could be effected by a spill, the probability that a spill would occur and the probability for a spill to occur or persist during periods when whales are present it is unlikely that bowhead whales would be contacted by oil. Significant adverse affects would only be expected if all of the low probability events occurred at the same time. Cumulative effects from the more likely small spills are likely to have only a minor impact on the bowhead whale population.

4.7.7.10-b Spectacled and Steller's Eiders

Available information indicates that past, present, and future activities in the planning area, along migration routes, or on winter ranges could potentially contribute to cumulative effects on spectacled and Steller's eiders. These activities include subsistence and sport harvests (and associated lead contamination of eider habitat); commercial fishing; commercial development; wildlife research and surveys; proposed oil and gas exploration and development in nesting and wintering habitats; predation; environmental contamination; marine shipping; and recreation. Global climate regime shifts may also impact vegetation and other resources that could influence eider survival. Some of these activities may affect eiders at latitudes south of the Beaufort Sea and outside the summer breeding season. Activities outside of the breeding grounds could result in oil or other toxic pollution effects (e.g. lead), additional disturbance during the nonbreeding periods, or habitat loss or degradation that would add to cumulative impacts on listed eiders.

4.7.7.10-b.1 Past and Present Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Activities not related directly to oil and gas development that occur on the North Slope, including wildlife research and survey activities, subsistence harvest, predation, village expansion, and potential environmental contamination, may have contributed to past cumulative effects to eiders. These impacts were usually localized and would have affected only small numbers of eiders and likely did not accumulate at the population level.

Noise and ground activities at summer camps could have disturbed feeding, nesting, or brood-rearing eiders in close proximity to the camps, potentially affecting the bird's energy budget and productivity. Although pedestrian traffic has been shown to be particularly disruptive to some waterfowl and raptors (Roseneau et al. 1981; Ritchie 1987; Johnson et al. 2003b), some eiders may have acclimated to predictable daily activities of camp personnel. Disturbance to birds from

aircraft traffic and camp activities likely had the greatest affect within approximately 2,280 feet of the camps and little or no effect beyond 6,500 feet (Johnson et al. 2003b). Ward et al. (1999) studied brant response to fixed-wing and rotary-wing aircraft and reported brant response to aircraft at a lateral distance to 3 miles, although the majority of birds responded to aircraft that were within a lateral distance of ½ mile or less. The greatest response to aircraft altitude occurred between 1,000 and 2,500 feet. Nesting eiders may not be as sensitive to aircraft as molting or staging waterfowl. No significant changes in behavior were noted for eiders adjacent to a construction site in the Colville River Delta and subject to repeated fixed and rotary winged aircraft (Johnson et al. 2006). However, these are preliminary results and should only be viewed cautiously.

Tundra-nesting eiders near summer camps may have also suffered mortality or egg loss due to predators attracted to anthropogenic sources of food at camps.

Aside from direct mortality due to subsistence harvest, the accumulation of lead shot in eider foraging habitat in the Y-K Delta has likely been responsible for loss of spectacled eiders and likely effects nest success (Flint et al. 1997, Grand et al. 1998, Flint et al. 2000). This may be the most significant direct anthropogenic impact currently effecting Alaska's population of spectacled eiders.

Non-oil and gas development at former military and other government sites and in villages has caused the loss of habitat and increased levels of disturbance. These sites also provide a potential starting point for hunting trips. Approximately 2,500 acres have been developed, with most of this development along the coastline, where eiders are found. Although there is limited information on historic numbers of eiders found in these non-oil and gas developed areas, development, loss of habitat, and disturbance, coupled with hunting pressure at a "shooting station" near Barrow, and other recreational and subsistence hunting near other villages, has caused the loss of birds and habitat that has accumulated.

Oil and Gas Exploration and Development Activities

Seismic Activity and Exploration

Loss of habitat and disturbance are the two primary factors associated with seismic activities and exploration that could affect eiders on the North Slope. Most seismic surveys and exploration drilling activities occur during the winter months when eiders are not present in the planning area. Therefore, these activities would have no direct impacts that would accumulate.

The use of airguns for boat-based seismic work in Teshekpuk Lake during the summer may have temporarily displaced eiders from feeding habitats while surveys were being conducted. Spectacled eider densities are medium high to high northeast of Teshekpuk Lake, and Steller's eiders have been seen nesting near Teshekpuk Lake (see maps 3-32 and 3-33). Eiders near the shoreline could have been temporarily or permanently displaced from nests by boat disturbance, however, these surveys have only occurred a few times in the past, and it is unlikely that effects to eiders have accumulated.

Rolligons and track vehicles used during seismic exploration have left tracks on tundra habitats and many of these tracks are still observable years later (Kevan et al 1995). However, less than 100 acres of habitat has scars persisting today that could result in habitat loss for eiders. Studies of seismic and camp-move trails created in the 1980s showed that only a small portion of seismic trails were still in evidence 8 years later, but that 5% of camp-move trails still showed

moderate to high disturbance. Use of lightweight vehicles, dispersing traffic patterns, minimizing sharp turns, and requiring surveys to be done when snow and frost cover is adequate to protect the tundra have helped to minimize damage to vegetation used by eiders (Walker 1996).

Other sources of vegetative loss included gravel pads, airstrips, and roads near gravel structures at exploration sites. Peat roads constructed in the 1960s caused disturbances to tundra habitats that persist today. However, some evidence suggests that bird use of peat roads is similar to that of adjacent areas of undisturbed tundra (TERA 1991). Based on NRC (2003), by 2001, approximately 1,200 acres had been impacted by exploration sites in the past, and 740 acres of disturbance were still evident. Most of these sites were developed before 1977, thus, their effects on the vegetative landscape have persisted for decades, and are likely to persist for several more decades. As industry has shifted towards use of ice roads and ice pads during exploration, loss of habitat from seismic activities and exploration has slowed greatly. Still, ice roads and pads have effects that could impact eider habitat for several years, but would be unlikely to accumulate.

Water used in the construction of ice roads and pads has been withdrawn from deep lakes in areas adjacent to the road and pad locations. Winter water withdrawal has altered lake levels and adjacent habitats, although flooding and recharge during spring break-up have minimized the potential for long-term effects (Rovansek et al. 1996). Since use of lakes in the past has varied, and few lakes would have had water withdrawn over several years, it seems unlikely that the effects of past use of lakes for water withdrawals would accumulate.

Infrastructure and Road and Pad Construction

Effects to birds from loss of habitat from road and pad construction and gravel mining, and disturbance associated with development and production activities have occurred in the past and persist today. Gravel roads, gravel pads, and gravel mines have caused the direct loss of eider habitat. Not all areas disturbed provided habitat to spectacled or Steller's eider, but a significant portion of the existing oil infrastructure is within the area used by eiders.

Although over 500 acres of peat roads still show evidence of disturbance, it is not clear that this disturbance has resulted in negative impacts to birds. Gravel footprints have impacted over 9,200 acres, and loss of vegetation and habitat associated with gravel footprints persists today. Gravel mines cover an additional 6,360 acres; however, 80% of those mines occurred in rivers (NRC 2003). Over 4,500 acres of gravel mines have been reclaimed, much of it to deepwater lake habitat that would have some value for eiders.

Disturbance

Numerous types of disturbances have resulted from oil and gas exploration, development, and production activities, including those caused by aircraft, vehicular, pedestrian, and vessel traffic, construction and drilling activities, noise and activity at facilities, and predator attraction. Impacts have been most prevalent where facilities were located in habitats with high bird concentrations, or if species with low population numbers or declining populations, such as threatened eiders, were disturbed.

Murphy and Anderson (1993) reported disturbances to birds as far as 500 to 685 feet from roads. Avoidance of roads, however, may have been related to an avoidance of heavily dusted areas on tundra adjacent to roads with high traffic levels rather than an avoidance of vehicular

activity itself. Disturbance to waterfowl from aircraft is well documented (e.g., Schweinsburg 1974; Ward and Stehn 1989, Derksen et al. 1992, McKechnie and Gladwin 1993; Ward et al 1999). Johnson et al. (2003b) conducted the most thorough study of aircraft disturbance to waterfowl in Arctic oil fields at the Alpine field. Responses of birds to aircraft included alert postures, interruption of foraging behavior, and flight. Aircraft disturbances could displace birds from feeding habitats and negatively impact energy budgets. Gollop et al. (1974b) and Ward et al. (1999) suggested that helicopters may be more disturbing to wildlife than low-flying fixed-wing aircraft, although Balogh (1997) indicated that fixed-wing aircraft flown at 150 feet AGL often caused spectacled eiders to flush, while helicopters flown at similar altitudes in the vicinity of Prudhoe Bay did not. The potential effects of routine aircraft flights into airstrips would range from bird avoidance of certain areas to abandonment of nesting attempts or lowered survival of young. Johnson (1984) reported that at least three successful common eider nests were located within 975 feet of a helicopter pad on Thetis Island that averaged approximately 12 trips per day. Although the potential exists for displacement of some nesting birds near routinely used aircraft landing sites as a result of numerous overflights, landings, and takeoffs, some birds may habituate to routine air traffic. Given the relatively low density of spectacled and Steller's eiders nesting in the NPR-A, disturbance resulting from aircraft activity would likely affect only a small percentage of the total populations of spectacled and Steller's eiders. The cumulative effects of disturbance on the North Slope have added only incrementally to impacts on eiders.

Predators

Predators such as glaucous gulls, Arctic foxes, ravens, and grizzly bears are attracted to anthropogenic food sources associated with oil field development, which may cause increased predation pressure on tundra-nesting eiders. There is evidence that nesting success for several species of ground-nesting birds may be lower in oil fields than in undeveloped areas (Troy 1996; Anderson et al. 2000; Sedinger and Stickney 2000). It is not known if these effects to eiders have been substantial enough to accumulate.

Collisions

Bird mortality has resulted from collisions with buildings, vehicles, aircraft, vessels, towers, pipelines, platforms, or other structures associated with onshore and offshore oil and gas development. Known collision mortality to spectacled and Steller's eiders have occurred in Barrow and Deadhorse- probably the result of collisions with overhead lines and guywires (MMS 2003 citing FWS unpublished data). Offshore activities are most likely to impact birds during the late summer/fall staging period, when relatively large numbers eiders, and other waterfowl are staging and molting in marine areas. No spectacled or Steller's eiders were known to collide with the Northstar installation over 3 years of monitoring (Day et al. 2004). Eiders have been reported colliding with fishing and research vessels in early spring (Lovvorn et al. 2003). Eider collisions with vehicles, buildings or oil field infrastructure probably do not represent a significant source of bird mortality at the population level. However, eider losses due to collisions in developed areas accumulate with increases in development and add incrementally to other impacts.

Spills

Only two large oil spills have occurred on the North Slope. (see **section 4.2.2.1**). These were limited to small areas and were properly cleaned up with minimal resulting impacts to the environment. Several small spills have occurred but cleanup and rehabilitation efforts have

been successful and relatively few birds have been impacted (NRC 2003). There are no records of spectacled or Steller's eiders or their nests being directly impacted; however, clean-up efforts may have destroyed habitat, disturbed birds, and prevented localized nesting. Given the relatively low frequency of off-pad spill events and that spills have all occurred east of the Colville River in areas of relatively low eider densities (almost no Steller's eiders have been reported in these areas in the last several years), it is unlikely that any population effect would persist and accumulate.

Marine Activities

Offshore oil exploration and development in state or Federal marine waters of the North Slope rely on helicopter and barge traffic more than on fixed-wing flights. Much of this activity occurs during the winter when eiders are not present. However, helicopter activity, barge and crew vessel traffic, and spill response training activities also occur during the summer. During the summer open-water seasons of 2001 and 2002 at the Northstar development off Prudhoe Bay, helicopter activity ranged from 477 to 989 round trips, crew vessel activity ranged from 469 to 824 round trips, and barge traffic ranged from 63 to 64 round trips (Williams 2002, Williams and Rodrigues 2003). Vessel traffic not related to oil development also occurs in marine waters off the coast of the North Slope. These disturbances may have displaced eiders from feeding and loafing areas and had a minor, short term impact on eiders.

Factors Outside of the North Slope

Subsistence harvest of spectacled eider adults and eggs has impacted these species, although overall numbers of birds and eggs taken over their entire range are not known. Aside from direct mortality due to subsistence harvest, the accumulation of lead shot in eider foraging habitat in the Y-K Delta is likely responsible for loss of spectacled eiders. It is currently illegal to use lead shot while hunting waterfowl, although lead shot is allowed for hunting upland species. Illegal use of lead shot for hunting waterfowl, or legal use of lead shot for hunting upland species near waterfowl habitats, could contribute to the effects of lead poisoning on eider populations. Programs currently are underway by the USFWS and the NSB to inform hunters of harvest closures on these two species in an effort to decrease this source of mortality. Development along migration corridors and in wintering areas may result in habitat loss or disturbance that add to the cumulative impacts on bird populations. All of these factors can add to the cumulative loss of individual birds, and in some instances, can have population-level effects.

Summary of Past and Present Impacts and Their Accumulation

Approximately 2,500 acres have been disturbed from non-oil and gas development on the North Slope. Although only a small portion of this area would have been used by eiders, much of it has occurred along the coastline and near Barrow, areas where spectacled and Steller's eiders are often seen (see maps 3-32 and 3-33). Oil and gas activities have directly impacted approximately 13,000 acres of tundra, and indirectly impacted a greater amount through dusting, impoundments and thermokarst, although these indirect effects have not been shown to impact or benefit eiders. Eider populations are greatest northeast of Teshekpuk Lake, and west of the planning area, thus the amount of eider habitat impacted by past and present development is probably minor. Currently, the impacts of predators on bird populations may be reduced compared to the early years of oil field development, as industry has reduced the amount of garbage that is available in fields to attract predators. Other effects, including disturbance, are difficult to measure, but are likely accumulating as the number of developments and the

amount of developed area increase. The gravel footprints of current developments are reduced compared to the footprints of previous oil field development, resulting in less habitat loss in modern oil fields. However, new development often relies on aircraft support for transportation of personnel and equipment that can increase disturbance to feeding, nesting, and molting eiders. Habitat loss and disturbance can add incrementally to the impacts of development on eiders.

4.7.7.10-b.2 Future Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Subsistence harvest of spectacled eider adults and eggs apparently continues to impact these species, although overall numbers of birds and eggs taken over their entire range are not known. Aside from direct mortality due to subsistence harvest, the accumulation of lead shot in eider foraging habitat in the Y-K Delta is likely responsible for loss of spectacled eiders. Although the proposed development scenario does not include a road connecting Nuiqsut with roads in the planning area, future construction of a road could allow access that would increase subsistence hunting pressure on spectacled and Steller's eiders, and increase the potential for lead shot contamination of eider feeding habitats. It is currently illegal to use lead shot while hunting waterfowl, although lead shot is allowed for hunting upland species. Illegal use of lead shot for hunting waterfowl, or legal use of lead shot for hunting upland species near waterfowl habitats could contribute to the effects of lead poisoning on eider populations. Programs currently are underway by the USFWS and the NSB to inform hunters of harvest closures on these two species in an effort to decrease this source of mortality. However, lead shot appears to persist in the environment and any additional lead shot would be additive to past amounts, incrementally increasing the chance of eider exposure and further reducing survival. DEW-Line sites, other military facilities, villages, airstrips, and other non-oil and gas infrastructure are likely to persist into the indefinite future. Villages are likely to increase in size, causing the potential loss of additional habitat.

Oil and Gas Exploration and Development Activities

Aircraft and Vessel Disturbance

Central Production Facility developments with satellite fields connected by gravel roads similar to what is expected in the planning area would be expected for new development elsewhere on the North Slope, including the Northwest NPR-A planning area. In addition, several staging areas and gravel extraction sites are also proposed. If developments east and west of Prudhoe were not connected to each other and to North Slope communities or the existing oil fields of Prudhoe Bay by roads, they would likely require substantial fixed-wing aircraft and helicopter support, and occasional barge support during periods when eiders are present.

Oil exploration and development, which could occur in state or Federal marine waters offshore of the planning area, would rely more on helicopter and barge traffic and less on fixed-wing flights. Much of this activity would occur during the winter when eiders are not present. However, helicopter and barge and crew vessel traffic, and spill response training activities would also occur during the summer. During the summer open-water seasons of 2001 and 2002, helicopter activity at the Northstar Development near Prudhoe Bay ranged from 477 to 989 round trips in each season. Crew vessel activity ranged from 469 to 824 round trips, and barge traffic ranged from 63 to 64 round trips (Williams 2002, Williams and Rodrigues 2003).

Exploration and development conducted as a result of the Beaufort OCS leases is expected to result in increased vessel and aircraft traffic but because of spectacled and Steller's eider sparse distribution and typical small flock size offshore and seasonal presence these effects are expected to be minimal, and impact only individuals through disturbance related reduced fitness. MMS does not believe that these impacts would be sufficient to cause population declines but may slow population growth (MMS 2003, 2006).

The Chukchi Sea OCS lease program is also expected to result in increased aircraft and vessel traffic. Of particular concern is the Designated Critical Habitat for eiders in Ledyard Bay (USFWS 2001). All proposed alternatives prohibit seismic surveys at any time and overflights below 1500 feet of the Ledyard Bay Critical Habitat during times when eiders are typically present MMS 2006; p II-21). However this restriction is for seismic activity only. No such restriction is included for development and operation. Most waterfowl are particularly sensitive to disturbance during staging or molt (Ward 1994, Ward et al. 1999). The Ledyard Bay area has been used by as many as 33,200 spectacled eider. The molting population there is believed to include the entire population of successful females and young from the Arctic Coastal Plain (Petersen et al 1999). Overflights or vessel traffic through this area when eiders are present could result in disturbance effects to a large number of birds.

Fixed-wing and helicopter air traffic activity at the Deadhorse Airport, and at the Kuparuk and Alpine field airfields, is likely to represent the greatest source of air-traffic disturbance to eiders from currently developed areas. Any aircraft-related disturbance from new developments on the North Slope would represent additive effects. Continued activity to support future development on the North Slope likely would result in additional low-altitude flights over nesting, brood-rearing, staging, or migrating spectacled and Steller's eiders. The effects of disturbance from these activities could result in temporary or permanent displacement of foraging, nesting, brood-rearing, or molting/staging eiders, temporary or permanent nest abandonment, or alteration of eider energy budgets. Long-term displacement (1 year or more) from heavily used corridors could result in fewer young produced and somewhat lower survival of adults. However, some individuals might tolerate this level of disturbance and nest, rear broods, or forage within the air traffic corridor. Given the relatively low density of spectacled and Steller's eiders nesting in the NPR-A, disturbance resulting from aircraft activity would likely affect a small percentage of the total populations of spectacled and Steller's eiders.

Vessel traffic associated with onshore or offshore development, could disturb spectacled and Steller's eiders. The majority of barge traffic used to transport fuel, equipment, and supplies for onshore development would likely be staged from Prudhoe Bay, which has road access to ports at Anchorage. Barge traffic from Barrow would arrive from the west. Barge traffic would not occur until the open-water period begins in mid-July, and would not cause any disturbance to eiders migrating in the spring. Eiders staging in Harrison Bay or Smith Bay prior to fall migration could be temporarily displaced from feeding habitats by barge traffic, although most spectacled eiders would likely be further offshore than projected barge routes. Barge traffic from the Prudhoe Bay area to support offshore development could potentially impact eiders by causing temporary or permanent displacement from preferred feeding habitats. The extent of the impacts would depend on the location of the offshore development, the number of trips, and the vessel route. These additional effects would be additive with respect to cumulative effects to North Slope eider populations.

Vehicle Disturbance

Vehicular traffic and machinery noise and activity have the potential to affect spectacled and Steller's eiders in newly-developed areas on the North Slope. Similar types of disturbance occur in association with activities in existing North Slope oil fields. Any new disturbance to eiders from vehicles would be additive to existing disturbance at the population level as new development would be unlikely to result in significant additional effects to birds already subject to vehicle disturbance, but would introduce disturbance effects to birds not previously subject to disturbance.

Habitat Alteration

Although the increase in the amount of area disturbed by oil and gas development has slowed dramatically in recent years, the cumulative effects analysis for this EIS (**section 4.7.3.3**) assumes that over the life of the oil and gas development that could occur in Northeast NPR-A, approximately 3,850 acres of additional gravel placement (direct removal of tundra) to support oil and gas development outside of NPR-A, and another 3,500 acres of new gravel could be placed within the Northwest NPR-A planning area. Gravel mines could result in as much as 1,470 additional acres impacted.

Temporary habitat loss or alteration could result from delayed snowmelt caused by accumulation of snow on tundra adjacent to roads and pads, dust deposition on tundra adjacent to roads and pads, thermokarst, seismic or other winter activities that affect tundra vegetation. The formation of impoundments adjacent to roads and pads could result in temporary or permanent habitat loss or alteration. There is some evidence that impoundments may provide some additional habitat for spectacled eiders (Anderson et al. 1992; Warnock and Troy 1992; Noel et al. 1996), and that the formation of impoundments may not have negative impacts on threatened eiders. Similar types of habitat loss and alteration have occurred in the existing North Slope oil fields, and could occur in the Northwest NPR-A if future oil and gas development occurs there.

These impacts could be additive to the impacts to eider habitat that have accumulated in the past and persist today, but in the context of the ACP and North Slope, these cumulative impacts would be small. Based on direct historic and predicted conversion of tundra to gravel (21,000 acres). These estimates do not take into account whether the acres historically and potentially impacted could have or does provide habitat for eiders.

Predation

There is evidence that predators of eiders, such as the Arctic fox, glaucous gull, and common raven, could be attracted to areas of oil and gas field development by anthropogenic sources of food and denning or nesting sites. Increases in the numbers of predators in areas of development could have an additive impact on the effects of predation on threatened eiders. In recent years, North Slope oil field developers have installed predator-proof dumpsters to minimize attraction of predators to development. Lease stipulations were established, in part, to prevent human-caused increases in predator populations and require the adoption of methods to avoid attracting wildlife to sources of food, and to use the best technology available to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, and foxes. Monitoring at Alpine indicated no increase in density of fox dens during construction, but a pair of ravens continued to nest at the facility despite efforts to preclude them (Johnson et al 2003).

Collisions

Eider mortality could result from collisions with buildings, vehicles, aircraft, vessels, towers, pipelines, platforms, or other structures associated with onshore or offshore oil and gas development. Offshore activities would be most likely to impact eiders during the late summer and fall staging periods, when relatively large numbers of eiders are found in marine areas. Migration pathways of eiders may include areas where offshore production facilities are constructed, so collisions between eiders and offshore structures, and watercraft and helicopters used for transport of personnel and equipment or responding to an oil spill, could occur. The potential number and locations of offshore sites and their effects on spectacled and Steller's eiders would be additive to existing effects in North Slope oil fields. Exploration and development in the Chukchi and western portion of the Beaufort in the nearshore areas would have the greatest potential for collisions. Eiders fly in small flocks, low and fast over water (Day et al.) and movements during spring and fall migrations are more likely to occur in darkness or poor weather conditions, all factors which can influence strike rates.

Spills

The oil industry is required to have oil spill response and cleanup capabilities, and it is expected that small spills in the planning area or in existing or future North Slope oil and gas fields would be contained and cleaned up before substantial impacts to eiders would occur. A large onshore spill released in the planning area during the summer season could affect pre-nesting, nesting, and brood-rearing eiders. In the immediate vicinity of the spill, some habitat contacted by oil would become unsuitable for nesting, brood-rearing, or foraging by eiders, and oil entering freshwater aquatic habitats could spread more widely, potentially entering river deltas and nearshore marine habitats. Direct mortality could occur from loss of insulating capabilities of feathers, should eiders come in contact with oil, or by ingesting of contaminated prey. These effects would be additive to the effects of a spill in the existing North Slope oil fields, or to the effects of potential future spills in the Northwest NPR-A. Spectacled and Steller's eiders could also be affected by oil spills in other coastal lagoons and marine areas in molting or wintering areas.

If future oil and gas field development were to occur in state or Federal marine waters offshore of the planning area, there would be a low probability of a large oil spill. If one or more spills were to occur, substantial losses could result to eiders if oil were released during the summer/fall season when eider flocks were present. The number of eiders affected could potentially total tens to hundreds of individuals. Using average estimated spectacled eider density calculated from the USFWS survey data in the central Beaufort Sea area from Harrison Bay to Brownlow Point, and average severity of spill-trajectory paths (and thus, exposure of birds to oil), a USFWS model estimated an average of two eiders would be exposed to a large spill (5,912 barrels) within 30 days in July (Stehn and Platte 2000). However, in late July one group of 100 individuals was observed, suggesting a potential for much higher mortality should a spill occur in an area of relatively high spectacled eider density. An offshore oil spill with the greatest potential to impact spectacled eiders would be one that occurred in the deeper offshore waters of Harrison Bay, rather than in the offshore waters to the east or the shallower nearshore waters. An oil spill could also contaminate prey populations in eider foraging areas at any time of year, resulting in secondary impacts to eiders by affecting productivity and/or survival. Likewise, a spill on shoreline or coastal marsh habitat could affect eiders that were moving from onshore brood-rearing areas to the marine environment, or that inhabited the area in subsequent years. Molting and/or staging spectacled or Steller's eiders are known to use the lagoon systems in offshore areas of the Beaufort and Chukchi seas and Norton Sound. A large

oil spill that entered Ledyard Bay could have significant population effects on not just the Arctic Coastal Plain population of spectacled eiders but also the world population. While such an event is possible, it is considered very improbable (MMS 2006).

4.7.7.10-b.3 Global Climate Change

Much research in recent years has focused on the effects of naturally-occurring or man-induced global climate regime shifts and the potential for these shifts to cause changes in habitat structure over large areas. Naturally occurring plant succession on the North Slope is a relatively slow process (Billings and Peterson 1980), but how future global climate change may affect this process is unknown. Although many of the forces driving global climate regime shifts may originate outside the Arctic, the impacts of global climate change are exacerbated in the Arctic (ACIA 2005). Temperatures in the Arctic have risen faster than in other areas of the world as evidenced by glacial retreat and melting of sea ice.

The increasing thickness of the active layer of soil above Arctic permafrost is likely to cause changes in moisture regimes and the distribution of vegetation types over much of the Arctic in coming years. Thawing of the permafrost may result in increased amounts of surface water in some areas. Areas of permafrost with substrates composed of fine-grained materials may be susceptible to drying, erosion, and desertification (ACIA 2004). Rising temperatures are likely to favor the expansion of the northern boreal forest into areas currently occupied by tundra. Studies suggest that climate change may increase woody vegetation on the North Slope (Chapin et al. 1995). Changes to the predominant vegetation type in areas dominated by sedges and grasses could influence use of those areas by threatened eiders. Global climate change may also result in an increase in shrubs at the expense of forbs and graminoid vegetation characteristic of arctic tundra. This could result in a loss of breeding-season habitat for threatened eiders. Rising seal levels resulting from increasing temperatures may further reduces the amount of tundra habitat available to nesting eiders by causing coastal erosion and by inundating low-lying areas. Such intrusion of salt water would be unfavorable to woody vegetation and would shift plant species toward those more tolerant of saline conditions (Funk et al. 2004). Salt marsh in general is considered high value habitat for waterfowl including the threatened eiders. These changes may be beneficial to some species, such as those associated with boreal forest or shrub habitats, but a reduction in the amount of tundra habitat available could negatively impact threatened eiders and other tundra-nesting birds.

4.7.7.10-b.4 Contribution of Supplemental Alternatives to Cumulative Effects

Alternative A:
Alternative A is assumed to result in the direct impact to 3,270 acres of tundra that could provide habitat to spectacled and Steller's eider. This number includes acres lost to gravel mines. This is approximately 9.8% of the area currently or expected to be impacted on the North Slope. If it is assumed that all past, present, and future development will occur within the area encompassed by the Arctic Coastal Plain Breeding Eider survey area (i.e. Larned et al, 2006) the total past and future gravel footprint would be approximately 0.44% of that area.

Aircraft, vehicle, and barge traffic would all increase under this alternative but to a lesser extent than the other alternatives. Cumulatively more eiders would be subject to overflights; however, most eiders would not be subject to more overflights as a result of the cumulative increase in air traffic. This is because development would take place over a wide area resulting in flights occurring across a greater extent of eider habitat, rather than increasing flight density in the same area. Regional hub type airports such as Barrow, Deadhorse, Alpine, and Kuparuk

would likely see increased flight density, and a cumulative increase in disturbances due to increased flight numbers.

Under Alternative A, the unlikely large oil spill offshore remains the most significant potential effect and could result in population consequences that would make the relatively minor existing and potential impacts from oil and gas development significant. The most significant known impact to eiders is lead shot exposure on the Y-K Delta and probably ACP. If lead is reducing fitness additional individually minor impacts could become significant cumulatively to eiders already in marginal condition due to lead.

Alternative B:
Alternative B is assumed to result in the direct impact to 3,716 acres of tundra that could provide habitat to spectacled and Steller's eider. This number includes acres lost to gravel mines. This is approximately 10.9% of the area currently or expected to be impacted on the North Slope. If it is assumed that all past, present, and future development will occur within the area encompassed by the Arctic Coastal Plain Breeding Eider survey area (i.e. Larned et al 2006) the total past and future gravel footprint would be approximately 0.45% of that area.

Aircraft, vehicle, and barge traffic would increase compared to Alternative A, be less than Alternative C, and be similar to Alternative D.

Other factors currently or potentially impacting eiders are the same as under Alternative A, a potential large offshore oil spill and the effects of lead. Whether the incremental increase in acres impacted and disturbance potential between Alternatives A and B when added to the cumulative effects considered is significant is speculative at this time. Where development actually occurs relative to eiders, the availability of alternate nesting habitat, and eider tolerance of development are all factors that are poorly known at this time. However, Alternative B opens some area north of Teshekpuk Lake not available under Alternative A where spectacled eider density is higher. In addition, development north of Teshekpuk Lake may increase the likelihood that full development of Northwest NPR-A would occur. Although Steller's eider are very rare in most areas of the North Slope, they are most concentrated in the area south of Barrow. If facilitating development in Northwest NPR-A resulted in additional development in this area, impacts to Steller's eiders would be more likely under Alternative B than in Alternative A.

Alternative C:
Alternative C is assumed to result in the direct impact to 4,649 acres of tundra that could provide habitat to spectacled and Steller's eider. This number includes acres lost to gravel mines. This is approximately 13.3% of the area currently or expected to be impacted on the North Slope. If it is assumed that all past, present, and future development will occur within the area encompassed by the Arctic Coastal Plain Breeding Eider survey area (i.e. Larned et al 2006) the total past and future gravel footprint would be approximately 0.46% of that area.

Aircraft, vehicle, and barge traffic would all be greater than under the other alternatives.

Although its individual impact would likely be higher than Alternatives A, B, and D, cumulatively it is hard to discern the relative incremental impact of Alternative C from other factors considered in this cumulative effects analysis. Therefore, Alternative C would be expected to have a similar addition to the cumulative effects as other alternatives when considered at that large scale. Alternative C is probably the most likely to facilitate

development in Northwest NPR-A. If facilitating development in Northwest NPR-A resulted in additional development in eider habitat, impacts to Steller's eiders would be more likely.

Alternative D:
Alternative D is assumed to result in the direct impact to 4,378 acres of tundra that could provide habitat to spectacled and Steller's eider. This number includes acres lost to gravel mines. This is approximately 12.6% of the area currently and expected to be impacted on the North Slope. If it is assumed that all past, present, and future development will occur within the area encompassed by the Arctic Coastal Plain Breeding Eider survey area (i.e. Larned et al 2006) the total past and future gravel footprint would be approximately 0.45% of that area.

Aircraft, vehicle, and barge traffic would all be greater than under Alternative A, Less than Alternative C and similar to Alternative B.

The cumulative addition of Alternative D would be very similar to that described for Alternative B.

4.7.7.10-b.5 Conclusion

The cumulative effects to spectacled and Steller's eiders caused by future developments both onshore and offshore of the planning area, and on land, including within the Northwest NPR-A, and east and south of the planning area, would be greater than those caused by activities associated with the Supplemental IAP/EIS alternatives alone. However, total acres of tundra conversion to gravel relative to the total amount of area covered by the ACP Eider survey is minimal; the contribution of Alternative A through D to the total expected cumulative tundra impacts ranges from 9.8% to 13.3% but the total acres of tundra impacted remain less than 1% of the tundra within the northern range of the eiders. Direct habitat impact estimates without location information of development and eiders suggest that cumulative habitat impacts would be very minor and that there is little or no real difference in the incremental contribution of each alternative. Because they each open areas north of Teshekpuk Lake cumulative impact under Alternatives B, D, and C would increase in that order. Facilitation of development in Northwest NPR-A could increase the total impact, but the assessment of acres impacted above and for each alternative includes the Northwest NPR-A development at its full potential.

The effects of disturbance from noise, aircraft, vehicle, and ship traffic, and other sources are likely to affect significantly more eiders than direct habitat impacts. However, the available information suggests that past disturbance effects have at least not caused population declines (population growth not significantly different than 0 after 14 years; Larned et al 2006), and vehicle and aircraft activity do not appear to result in changes in nesting eider density or nesting success (Johnson et al 2006). These studies are limited by precision (Larned et al 2006) and very short study period (Johnson et al 2006). Changes may occur to slowly to be detected results confounded by environmental variation. Future development in higher density eider areas may have different results. Further minor impacts resulting from existing development may have significant effects if future development results in population effects from a large offshore oil spill or disturbance of Critical Habitat resulting in abandonment and reduced fitness of a significant portion of the population.

There is likely little difference in the incremental affect of the Alternatives when viewed in the cumulative context; however, if assuming that alternatives that open areas of higher eider density and that a greater footprint equates to greater disturbance effects, Alternative C would result in the greatest contribution to cumulative effects to eiders, followed by D and B.

Alternative A would have the least. The long term effects of climate change and lead exposure are not known and may individually or combined result in significant population level effects. The influence of the alternatives and other development is likely to be minor and could be undetectable from the natural variation or separable from the effects of climate change or lead exposure.

4.7.7.10-c Polar Bear

Although some polar bears from the Chukchi Sea probably occur within the planning area, bears from the Southern Beaufort Sea (SBS) stock are expected to predominate (Amstrup 1995); therefore this analysis focuses on cumulative effects to the SBS population of polar bears.

4.7.7.10-c.1 Past and Present Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Activities not related directly to oil and gas development that occur within the range of the SBS Population and could affect polar bears, include: coastal development, wildlife research and survey activities, subsistence harvest, and environmental contamination, may have contributed to past and current cumulative effects to polar bears.

Coastal Development: Gravel placement for North Slope villages and military installations is estimated to have impacted approximately 2,500 acres (**section 4.7.2**). Most but not all of this development has occurred along the coast line. This development and associated disturbance have likely removed or made unavailable denning habitat, but likely has had limited if any impact on polar bears as most SBS bears historically denned offshore. Coastal development also likely increased disturbance effects to bears but there is no evidence that this has significantly affected the SBS population.

Wildlife Research and Survey Activities: The SBS stock of polar bears is one of the most studied in the world. Research and survey activities include denning surveys from aircraft, and telemetry studies, which include tranquilizing female bears from aircraft. Review of den occupancy and reproductive success suggest that these activities have no measurable effects on individual bears or the population (Amstrup 1993). The effects of research are unlikely to have affected the SBS stock of polar bears.

Subsistence Harvest: Before the Marine Mammal Protection Act became law in 1972, active sport hunting for polar bears off western and northern Alaska reduced the population (Amstrup et al. 1986). Following passage of the MMPA, marine mammals can be hunted only for subsistence and handicraft purposes by Alaska Natives, and, unless populations are declared depleted, there are no federally-imposed limits on this type of hunting. Since 1988, hunting of polar bears from the southern Beaufort Sea stock has been controlled by a conservation agreement between the Iñupiat of northern Alaska and the Inuvialuit of the western Canadian Arctic, who hunt a shared population (Nageak et al. 1991). The average number of SBS bears taken each year from 1995 to 2000 in the U.S and Canada is 51.8, below the estimated "potential biological removal level" of 59 (Angliss and Outlaw 2005). However, the calculated potential biological removal was calculated from a higher population estimate than the current estimate of approximately 1,500 (Regehr et al. 2006). Harvest of polar bears for subsistence purposes may reduce the rate of population growth, but since harvest rate has average below the potential biological removal, harvested bears are replaced by recruitment and it is unlikely the harvest has accumulated.

Environmental Contamination: The accumulation of contaminants in polar bears has been well documented. Schliebe et al. (2006; p 152 - 175) provide the most comprehensive review of contaminants and the potential biological effects they may have on polar bears. The following is a summary of Schliebe et al. (2006). Potential contaminants that may have or be affecting SBS polar bears include petroleum hydrocarbons from natural seeps, vehicles, and atmospheric or water transport, persistent organic pollutants, and heavy metals.

There is no evidence that petroleum hydrocarbon exposure to polar bears have effect individuals of the SBS stock. Natural sources remain, but have not increased, and while the non-oil and gas anthropogenic contribution may have increased over time, historic concentrations have likely degraded. There is likely some small increase in the potential for exposure but no evidence of an effect. Impacts are not likely to have accumulated.

Persistent organic pollutants (POPs) arrive in the arctic via many routes and mechanisms. Bioaccumulation of POPs in top level predators is common, and polar bears are reported to have some of the highest concentrations of arctic mammals (Braune et al. 2005). Some types of POPs have declined in polar bears overtime, others are new or increasing. No effects to the SBS population have been detected, but no controlled experiments have been conducted. Population level effects have been suggested for other populations, but the lack of information on biological thresholds to exposure prevents an estimate of past and present effects of POPs on the SBS population of polar bears. POPs have accumulated; however, their impacts are unknown, but could be having population level effects, or more likely contribute to the severity of other events.

Mercury is the heavy metal of primary concern to polar bears because of its toxicity in low concentrations and that it has increased significantly since the pre-industrial period. Mercury poisoning may manifest as neurological impairment, compromised immune response and damage to internal organs. However, marine mammals appear to tolerate relatively high concentrations of mercury and examples of mercury poisoning are few. Mercury has accumulated in the arctic and likely within polar bears. It has not been shown to be impacting individuals or populations but may be acting indirectly to increase the severity of other stressors.

Oil and Gas Exploration and Development Activities

Seismic Activity and Exploration: Onshore and offshore seismic activity has occurred within the range of the SBS stock for decades. It is likely that seismic and other exploration has resulted in numerous types and instances of disturbances including those caused by aircraft, vehicular, pedestrian, and vessel traffic, construction and drilling activities, noise and activity at facilities.

For most of the year, polar bears are not very sensitive to noise or other human disturbances (Amstrup 1993; Richardson et al. 1995). However, pregnant females and those with newborn cubs in maternity dens both on land and on sea ice are sensitive to noise and vehicular traffic (Amstrup and Gardner 1994). Seismic exploration has disturbed a bear in a maternity den (USDOI USFWS 1986). Current regulations require industry to avoid polar bear dens as much as possible (USDOI USFWS 1995b). Seismic and other exploration has likely resulted in impacts to individual bears, particularly denning females and may have resulted in decreased reproduction, but these effects are intermittent and not likely to accumulate or effect the population through time.

Oil and Gas Development: Oil and gas development on the North Slope has resulted in approximately 17,000 acres of tundra converted to grave or gravel mines. Several artificial offshore islands have been constructed as well as two grave causeways (West Dock and Endicott). Some polar bear denning habitat has likely been altered or made unavailable as a result of construction and human activity, however, the amount and effect is unknown, but likely minimal, since the majority of historic dens where offshore, and most land dens were to the east of major development (Amstrup and Gardner 1994).

Two polar bears have been killed in Alaska since 1968 in defense of life and property related to the oil industry; however, more than 30 were killed over the same period in Canada (Schliebe et al. 2006), at least some of these bears were from the SBS stock.

The MMPA restrictions and resulting interactions between the industry and U.S Fish and Wildlife service have likely played a large role in active avoidance and minimization of impacts to polar bears. Industry has undoubtedly impacted some polar bears but there is no evidence that this effect has resulted in changes to the population (USFWS 2007).

Spills

Onshore spills have been relatively common but generally small (NRC 2003), and offshore spills have been less common and smaller (USDOI MMS 2006). No spill has been associated with adverse effects on SBS polar bears.

Summary of Past and Present Impacts and Their Accumulation. Subsistence harvest likely has the largest anthropogenic impact on SBS polar bears, but is unlikely to have done more than level off population growth in some years. Contaminants are common in polar bears and have accumulated through time, but no effect on polar bears has been demonstrated; however, studies are lacking and contaminants may be acting indirectly by increasing the severity of other stressors. Still no apparent population effects are evident. Approximately 2,500 acres have been disturbed from non-oil and gas development and approximately 17,000 acres more from oil development on the North Slope. Although only a small portion of this area may have been used by polar bears much of it has occurred along the coastline and could have impacted denning bears and their habitat. Seismic and other exploration work has disturbed denning bears and likely resulted in at least some reduced reproductive output. DLP killings of polar bears have occurred but they are very few. Past and present effects (aside from early sport hunting) to polar bears are not believed to have adversely affected the SBS stock of polar bears and the current level of impact is expected to be sustainable by the population.

4.7.7.10-c.2 Future Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Activities not associated with oil and gas exploration in the future are expected to be continuations of those described for the past and present above (except for sport hunting in the US) although rates may change. With the exception of contaminants these activities are well managed and unlikely to impact polar bears significantly in the future through accumulation. The effects of contaminants projected into the future are largely unknown. Worldwide regulatory reform and compliance will play a role in the continued accumulation and subsequent effects. The potential remains that the effects of contaminants would remain sub-lethal with no overt effects, but when combined with other typically sublethal stressors such as disease or reduced food supply, may result in mortality.

Oil and Gas Exploration and Development Activities

Future effects of the oil and gas industry are likely to be similar to past effects and largely be limited to disturbance particularly to denning females and taking in defense of life and property. On and offshore seismic and other exploration activity is expected to continue and will have the potential to disturb polar bears. These activities are most likely to have adverse impacts during the late fall and winter when females are establishing or occupying dens.

Approximately 8,800 acres of new gravel for future development is expected to replace tundra. This total includes areas within the Northwest NPR-A planning area that are outside the SBS range; however it is expected that a large percentage of it will occur within areas used by polar bears and some denning habitat is expected to be lost. Development east of Prudhoe Bay onshore or at sea would likely have a larger potential to impact SBS polar bears because den density increases in those areas. Increased exploration and potential development offshore in the Beaufort may increase with concomitant increases in disturbance potentials. However, interactions between the industry and U.S Fish and Wildlife Service required by the MMPA, and implemented through Letters of Authorization are expected to continue to keep those potential effects minimal (USFWS 2007) and not result significant effects to the population. MMS predicted minimal effects (take of less than 10 bears over the life of the program) resulting from the Beaufort Sea OCS leases (USDOI MMS 2003; 2006).

The potential for a large oil spill – particularly at sea in broken ice – remains the biggest potential threat to polar bears (USDOI MMS 2006). Onshore spills would be less likely to impact a significant number of bears given the wide distribution of denning bears. A spill along the coast line, or in a river system, particularly east of Prudhoe Bay where land dens are most dense would be the most likely to impact more than a few bears.

4.7.7.10-c.3 Global Climate Change

The potential effects of climate change on polar bears are extensively reviewed in Derocher (Derocher et al. 2004, Schliebe et al. 2006). If climate change proceeds as most accepted models predict it will have significant effects on polar bear populations world-wide. After considering multiple individual factors potentially affecting polar bears into the future, the U.S. Fish and Wildlife Service determined that only the potential effects of climate change on polar bears warranted the proposal the polar bears be listed under the Endangered Species Act (USFWS 2007). Climate change is expected to act on polar bears by causing reductions in the amount and seasonal extent of sea ice, reducing access to prey (ringed seals) and denning sites. Increased spring precipitation may also result in den collapse killing females and young. Increased onshore denning and apparent increase in dens it the eastern portion of the SBS stock's range is likely associated with changes in ice conditions and seasonality (Amstrup, unpublished data in Schliebe et al 2006).

4.7.7.10-c.4 Contribution of Supplement Alternatives to Cumulative Effects

Alternative A

Seismic activity is expected to be similar under all alternatives. While seismic exploration has the potential to affect polar bears, management tools currently in use appear to largely limit the potential for adverse impacts (Schliebe et al. 2006).

Alternative A is assumed to result in the direct impact to 3,270 acres of tundra, some portion of which could provide denning habitat for polar bears. Development would be limited to areas south of Teshekpuk Lake; therefore, would not be expected to alter coastal denning habitat in that area. Aircraft, vehicle, and barge traffic would all increase under this alternative but to a lesser extent than the other alternatives. These activities have not been shown to impact polar bears, although some individuals may be affected. Compliance with MMPA and related procedures as well as lease stipulations expected to reduce the likelihood of impacts.

Under Alternative A, the unlikely very large oil spill (VLOS) along the coast or entering marine waters remains the most significant potential effect and could result in population consequences. A VLOS that contacted a substantial portion of the population could make the relatively minor existing and potential impacts from oil and gas development and other activities significant by shifting the population level downward and increasing the relative effects of what are currently believed to be minimal impacts.

Alternative B

Seismic exploration is expected to be similar in extent among alternatives with similar potential of disturbance of females in dens. Alternative B is assumed to result in the direct impact to 3,716 acres of tundra that could provide denning habitat for polar bears. Although the relative increase in potential direct impact is minor, because coastal areas north of Teshekpuk Lake would be made available for leasing under this alternative, the potential for impacts to denning habitat are higher.

Development north of Teshekpuk Lake may increase the likelihood that full development of Northwest NPR-A and/or offshore development would occur. The NEPA documents for Northwest NPR-A and the Beaufort Sea OCS leases assume full development and the potential cumulative addition of each is as discuses above. Alternative B makes it somewhat more likely that the full development scenario for those areas may actually be reached compared to Alternative A.

Aircraft, vehicle, and barge traffic would increase compared to Alternative A, be less than Alternative C, and be similar to Alternative D.

As with Alternative A, the unlikely very large oil spill (VLOS) along the coast or entering marine waters is the most significant potential effect and could result in population consequences. A VLOS that contacted a substantial portion of the population could make the relatively minor existing and potential impacts from oil and gas development and other activities significant by shifting the population level downward and increasing the relative effects of what are currently believed to be minimal impacts.

Alternative C

Alternative C is assumed to result in the direct impact to 4,649 acres of tundra. Seismic activity is expected to be equivalent to the other alternatives, while aircraft, vehicle, and barge traffic would be greater than all other alternatives. Although the entire area north of Teshekpuk Lake is available for leasing under this alternative, the ¾ mile coastal buffer required by Lease Stipulation K-6 would protect most coastal denning habitat. However because more area is made available for leasing, and more development is expected, this alternative is expected to have the greatest potential to impact polar bears.

Development north of Teshekpuk Lake is most likely under this alternative and could affect the greatest area of any alternative. This makes Alternative C the most likely to influence development in Northwest NPR-A and/or offshore. As with other alternatives, it is not expected to result in additional development in these areas, just to make it more likely that development would occur at the estimated amount.

A VLOS reaching marine waters would be the only impact associated with development that could have population level effects. Such an event is slightly more likely under this alternative, but is still considered extremely unlikely, and it is more unlikely that the combination of location of the spill and bears necessary to impact sufficient individuals to result in population impacts would occur.

Alternative D

Alternative D is assumed to result in the direct impact to 4,378 acres of tundra. Seismic activity is expected to be equivalent to the other alternatives, while aircraft, vehicle, and barge traffic would be greater than all other alternatives. Although the entire area north of Teshekpuk Lake is available for leasing under this alternative, the ¾ mile coastal buffer required by Lease Stipulation K-6, and protections for goose molting lakes (K-4) would protect most coastal denning habitat. However compared to Alternatives A and B, Alternative D has a greater potential to impact polar bears.

Alternative D also could facilitate development in Northwest NPR-A and/or offshore. The potential influence under Alternative D is expected to be similar to Alternative B since development in the northwestern corner of the planning area is expected to have the most influence on adjacent developments.

As with the other Alternatives a VLOS poses the single greatest threat, but such an event remains unlikely and is not expected to occur.

4.7.7.10-c.5 Conclusion

Alternative C would contribute the greatest potential addition to cumulative impact among the alternatives, while Alternative A the least. However, when considered cumulatively with the other historic and potential future actions, there is little difference between the alternatives regarding potential to impact polar bears relative to the cumulative combination of all effects. Historic sport hunting depressed the SBS population in the past, but the population is believed to have recovered. Oil and gas development has not and is not expected to result in significant impacts to the population (USFSWS 2006). A large oil spill, particularly one offshore in the Beaufort Sea could impact a significant number of bears in the SBS population (MMS 2006).

Non-oil and gas activities are well managed and do not appear to be causing population level effects. The lack of information regarding the effect and accumulation of contaminants prohibits fully understanding those effects, but there is no current evidence that contaminants are affecting the SBS population (USFWS 2007).

Recent past, present, and reasonably foreseeable actions that could affect polar bears are not expected to accumulate to the level that result in population level effects. The effects are either well managed, (e.g. subsistence harvest, seismic and development actions under the MMPA) or rare (e.g. industry related DLP killing) (USFWS 2007).

Climate change poses the biggest threat to polar bears and is expected to result at least in a change in distribution and at most possible extirpation through reduction of sea ice extent and seasonality (Derocher et al. 2004, USFWS 2007). Considering the effects of development into the future in the context of climate change suggests that stresses to polar bears caused by climate change may be exacerbated by direct anthropogenic impacts. Impacts that without climate change would result in minimal additional energy expenditure, limited reductions in reproductive success, or mortality rates, but remain within the resilience capacity of individuals/populations could increase in magnitude with the addition of climate change stressors and result in increased/additional mortality or chronic reproductive failure. The number of encounters (impact likelihood) could also increase if more bears are onshore for longer due to sea ice reduction. Impacts that are currently non-significant may become significant in the context of climate change. Current mitigation and avoidance measures used for development and management of subsistence harvest have prevented significant effects. Continuation of these efforts coupled with an active monitoring program and adaptive management could reduce the incremental contribution of direct anthropogenic addition to the effects of climate change. Climate change by itself may still result in significant impacts to polar bears, but continued good management should reduce the potential additive effects of development and resource management.

4.7.7.11 Cultural Resources

Cultural resources, including archaeological and historic sites and materials as well as traditional cultural properties, have a very limited ability to absorb cumulative impacts. Cultural resources are not a renewable resource. Cultural resources risk being destroyed by erosion, construction, excavation, data collection, and looting, through the removal of artifacts from their surrounding contexts, moving the material such that it loses context, or the removal or re-deposition of artifacts and their surrounding context to another location. Cultural properties, including camps, cabins, hunting and fishing sites, graves, and areas of particular religious or traditional importance, lose their integrity, and thus their potential eligibility for the NRHP, when they become degraded as a result of natural or human disturbance processes, or when the people who value these places can no longer access them, thus losing their cultural connection to the site over time.

The following section discusses the cumulative impacts on cultural resources as they occur from the past into the reasonably foreseeable future (1900-2100). Several key factors, as discussed in **section 3.4.1**, could contribute to impacts on North Slope cultural resources during this time period, including oil and gas exploration (1920s through the present), military activity following World War II (e.g., DEW-line and White Alice Communication System [WACS]), Federal laws and regulations concerning impacts to cultural resources (e.g., National Historic Preservation Act [1966], NEPA [1969], Archaeological Resources Protection Act [1979]), archaeological surveys (Section 106 and NPR-A 105(c) studies), and the collection of oral history and traditional land use sites by the NSB (e.g., Traditional Land Use Inventory).

4.7.7.11.1 Past and Present Effects and Their Accumulation

Before oil and gas exploration and development, North Slope cultural resources were subject only to the effects of the natural environment, such as the forming, deforming, and destroying of existing sites, and the effects of human activity, such as Native people reusing found objects and materials, and explorers and other visitors taking material from the sites. Activities which have had the greatest affect on cultural resources in the NPR-A and along the Arctic Coast are most

likely linked to both oil development and military activity, given that the area was designated as a Naval Petroleum Reserve in 1923.

Interest in the geology and archaeology of the North Slope began in earnest at the beginning of the 20th century, but access was generally limited to coastal or easily accessible areas (see **section 3.4.1.8, *European/Euro-American Expansion, Exploration, and Ethnographic Research***). Effects to cultural resources in the NPR-A have been occurring since 1923 when oil and gas exploration and mapping began with USGS surveys of the Reserve, assisted by Native guides such as Simon Paneak. Early oil and gas ground-disturbing activities conducted by the U.S. Navy included exploratory drilling and geophysical and geological surveys, beginning in 1944, and shallow core tests and test wells drilled between 1945 and 1952. During this period, about 3,400 miles of seismic-reflection surveys and 391 miles of seismic-refraction surveys were completed within and adjacent to the Reserve (see **section 4.7.3.1, *Past Exploration, Development, and Production on the North Slope and in the planning area***). There has been little documentation of these early impacts, and there is no record of cultural resource identification or mitigation efforts from this early time period.

With the onset of the Cold War, military activity on the North Slope also affected cultural resources. During the 1950s, ground-disturbing activities associated with the rapid construction of the DEW-line and White Alice Communication System sites affected cultural resources; however, no effort was made during this period to mitigate effects to cultural resources potentially affected by industrial or military activities, despite protection provided to cultural resources under the Antiquities Act of 1906. Public testimony and historical literature have noted that cultural resources were disturbed or destroyed and access to traditional use sites was limited by industrial and military activity during this time period (Brown 1979). During the 1998 scoping meeting in Barrow for the Northeast NPR-A, Arnold Brower, Jr. noted that his grandfather's house and dwelling in Brownlow Point was demolished so that the DEW-line could have an airport in the same location.

Continued and increasing amounts of oil and gas exploration and drilling across the North Slope further affected cultural resources and Native peoples' relationships with their ancestral homelands. Following Alaska statehood in 1959, land selections were made by the state government, which did not include Native land ownership except as provided for under the Native Allotment Act of 1906. No effort was made at that time to inventory, identify, record, or document Native land use or historic and archaeological sites as a result of these land selections. As a result of this lack of strong legal protections, oil development and production during this initial period severely impacted cultural resources and diminished some peoples' relationships with their individual and collective history. Sarah Kunaknana related the following experience while testifying at the scoping meeting held for Sale BF in Nuiqsut in 1979:

> My name is Sarah Kunakanna and I have lived in this area since 1921. Our family stayed at Prudhoe Bay until late 1930's. Our old sod house is still standing today. When I visited last summer, I saw the pingos we used for duck blinds was a burning pit. Our place is a barge landing place instead of a fishing camp site. I guess people that are aware of Prudhoe Bay know that old shack on the east dock. That's where her house is still in position. That's the one she's talking about. There are a lot of old sites, camping sites, fishing sites along the line. They are there and are being threatened by development.

The most intense oil and gas development activity occurred during the 1970s and early 1980s (e.g., development of the Prudhoe Bay and Kuparuk oil fields, construction of TAPS and the haul road, and construction of a large portion of the roads, drilling pads, gravel sources, collector pipelines, and production facilities). These developments occurred following the passage of the NHPA (1966) and NEPA (1969). These laws mandated the identification of cultural resources potentially affected by developments and mitigation of the impacts. In addition, these developments resulted in the discovery of many previously undocumented cultural resources. In part, increased oil and gas exploration and development activity prompted the NSB to initiate the Traditional Land Use Inventory (NSB Contract Staff 1979; Schneider and Libbey 1979). In 1977 and 1978, an archaeological survey was conducted in selected areas of the NPR-A, as mandated by Congress under Public Law 94-258, the Naval Petroleum Reserves Production Act. This survey resulted in the identification of 728 cultural resource sites. The Archaeological Resources Protection Act of 1979 added additional protections for cultural resources on public or Native-owned lands. In addition, the Native American Graves Protection and Repatriation Act of 1990 provided protection for Native human remains, sacred objects, and associated funerary objects on Federal and Native-owned lands.

Summary of Past and Present Effects and Their Accumulation

Effects to cultural resources from road and pad construction and gravel mining, and disturbance associated with development and production activities have occurred in the past and persist today. Gravel roads, gravel pads, and gravel mines have caused surface disturbances that could have impacted cultural resources. Over 500 acres of peat roads were constructed, and gravel footprints have impacted over 9,200 acres. Gravel mines have impacted another 6,360 acres of vegetation, with over 5,000 acres of gravel being mined in rivers, where cultural resources are often found.

The above factors illustrate an improvement in the identification of cultural resources prior to ground-disturbing activities. Federal regulations and management stipulations regarding cultural resources were developed to mitigate impacts to cultural resources. However, increased development and exploration activities, while prompting the identification of the majority of cultural resources in NPR-A and the North Slope, have increased the cumulative effects to these resources.

4.7.7.11.2 Future Effects and Their Accumulation

Cultural resources are distributed unevenly across the North Slope. Areas with high probabilities of prehistoric and historic use are generally predictable, but specific subsurface cultural resources are often unknown until some sort of disturbance occurs, making it difficult to assess the cumulative impacts to cultural resources. The more oil and gas associated activities that occur, the larger the area affected and the greater the possibility that cultural resources would be impacted.

Increased oil and gas development activities on the North Slope would result in an increased need for gravel for infrastructure construction. The excavation of up to 2,200 acres of gravel by the end of this century for well pads, roads, and airstrips could impact cultural resources. Most prehistoric and historic sites are located on well-drained ground, and on the North Slope, well-drained ground often equates with gravel deposits, which are not common in the northern portion of the NPR-A. As a result, a gravel deposit with some degree of surface exposure would likely be associated with a cultural resource site. Therefore, the more gravel deposits with surface exposures excavated for the construction of permanent facilities associated with

development, the higher chance that impacts to cultural resources would occur. If a pipeline is built to bring North Slope gas to market, it would stimulate considerable gas development in the region. Many hundreds of miles of buried gas pipeline could result thus increasing the potential for impacts to cultural resources.

Because of their surface or near-surface stratigraphic contexts, cultural resources are not well protected by soil and vegetation, and are vulnerable to any surface or subsurface-disturbing activity. Exploration would be more likely to affect cultural resources than development activities, with the possible exception of gas pipeline burial, because basic exploration activities, such as seismic work, ice road and pad construction, and overland travel affect a much greater surface area than the construction associated with development. Although snow cover and frozen ground offer some protection to cultural deposits, they also cover the surface, making cultural resources difficult to recognize and avoid. In addition, most exploration-related operations occur in the low light conditions of winter; therefore, surveys of proposed activity areas and overland travel routes during the snow-free months preceding the initiation of winter exploration activities are important.

The effects of a large terrestrial oil spill on a cultural deposit would be directly related to the time of year and the context of the resource. If the spill occurred during the time of year when the ground is not frozen there would be a higher potential for an effect on cultural resources. Cultural resources could be contaminated by oil, making radiocarbon and other elemental assays valueless. However, the majority of effects would occur as the result of the cleanup rather than from the actual spill. During the winter months, both a spill and the resulting cleanup would have considerably less effects on surface and subsurface cultural resources, although warm oil could melt the snow and permafrost, damaging any underlying cultural resources. Hydrocarbon contamination could reduce the possibility that radiocarbon dating techniques could be reliably applied to affected material, making the dating of any recovered material problematic and increasing the cost of preserving and storing any such artifacts.

In general, impacts to cultural resources from future events would accumulate with effects that occurred in the past. Increased oil and gas exploration and development activities would increase the potential of impacting cultural resources. However, Federal and state regulations and management policies are likely to remain in effect and would continue to allow for the identification of cultural resources and mitigation of impacts prior to ground-disturbing activities.

4.7.7.11.3 Global Climate Change

Climate change could cause changes to the environment and habitats of the North Slope that could seriously affect cultural resources (ACIA 2004). Climate change could result in changes to vegetation coverage and type and the physical structure of the landscape itself (ACIA 2004). The thawing of permanently frozen ground could result in the erosion of river banks and beach bluffs, which would result in the destruction of known and undocumented historic sites as artifacts and sites were washed away. In addition, the thawing of permanently frozen ground could result in decreased preservation of subsurface cultural materials; natural processes, such as erosion, have exposed most known cultural deposits on the North Slope, particularly in areas with little or no organic soil and sparse vegetation. In most cases, this type of natural impact is viewed as positive rather than negative, as it reveals the presence of sites and usually generates few substantial effects. The action of flowing water, seasonal freezing and thawing (cryoturbation), thermokarsting, pingo and patterned earth formation, and solifluction can reveal cultural deposits, but can also cause minor impacts to cultural resources. Aggrading and

eroding shorelines along the Beaufort and Chukchi coastlines and in the barrier islands have likely exposed or destroyed a large number of sites in areas too remote for archaeological recordation, such as Thetis Island. Climate change will also cause the alteration of weather patterns and an increase in the frequency and intensity of spring and fall storms is likely to occur adversely effecting near-shore cultural deposits. Increased maritime activity along the coastal areas, in waterways, and in lakes could result in increased erosion due to boat wakes, exposing and possibly destroying coastal and riverine cultural resources.

4.7.7.11.4 Contribution of Supplement Alternatives to Cumulative Effects

The greatest potential for cumulative effects would occur under Alternative C, as the greatest portion of the planning area would be available for leasing, and the amount of development proposed under the alternative is greater than for the other alternatives. The potential for cumulative effects under Alternative B would be about 20% less than C while Alternative D would be about 10% less than C. Much of the northeastern portion of the planning area would be closed to leasing under Alternative B. Teshekpuk Lake would be deferred from leasing under Alternative D, but the likelihood of a large number of cultural resources being found in the lake would be small. However, RSO restrictions on permanent facilities in caribou habitat protection areas and the Goose Molting Area would limit the amount of surface disturbance that could occur north and east of Teshekpuk Lake; these restrictions would reduce the likelihood of cumulative effects to cultural resources within the planning area. Under Alternative A, about 600,000 acres in the Teshekpuk Lake Special Area would be closed to leasing.

Also to be considered is the potential contribution to regional cumulative impacts generated by the Northeast NPR-A Alternatives that could increase the possibility of adverse affects on cultural resources in the northeastern portion of Northwest NPR-A. Because Alternative A does not allow oil and gas infrastructure north of Teshekpuk Lake, an area believed to be of high oil and gas potential, it would probably serve to reduce/slow development in adjacent Northwest NPR-A in comparison with the other Northeast NPR-A Alternatives. Alternative C has the greatest potential for increasing cumulative impacts on cultural resources in northeastern Northwest NPR-A followed by Alternatives D and B.

Lease stipulations and ROPs developed for the 1998 Northeast IAP/EIS ROD and this supplement would reduce the likelihood of oil and gas exploration and development activities impacting cultural resources. These include actions that require operators use low-ground-pressure vehicles and cease operations when the spring melt of snow begins; prohibit exploratory drilling near any known, long-term cabin or campsite; require setbacks along rivers, streams, lakes, cabins, and the coast, providing additional protection for cultural resources and traditional/cultural land use areas; minimize cultural and resource conflicts through an orientation program for personnel that would include instruction on the importance of not disturbing archaeological resources and sensitivity to community values, customs, and lifestyles; require an inventory of known traditional land use sites (NSB TLUI sites; see Appendix I) prior to any field activity so that these sites can be avoided and any damage from field activities can be mitigated; and require a cultural resources survey prior to any ground disturbing activity. If cultural resources are identified during surveys, BLM guidelines and policy require that all potential effects to the resources be mitigated to the satisfaction of the land manager.

4.7.7.11.5 Conclusion

Cultural resources are nonrenewable, and displacement or contamination of cultural resources could affect the cultural and scientific values of the resource. The cumulative effects of oil and gas exploration and development within the planning area and across the North Slope are difficult to estimate given the scattered nature of cultural resource deposits, their surface or near-surface contexts, and difficulty in predicting their location. As long as surveys and inventories were completed prior to exploration and development, the effects on cultural resources would be minimized. The accidental discovery or damage to sites, presently known or unknown, would to some extent damage those sites, but would also require measures to recover or record the remaining material, adding that information to the archaeological record of the North Slope.

In this case, Alternative A would contribute the least toward cumulative impacts with the potential to directly and indirectly generate adverse affects on terrestrial cultural resources on the North Slope. Alternatives B, C and D have a greater potential for creating cumulative impacts because all of those Alternatives allow more area of high oil and gas probability to be leased (submerged off-shore cultural resources, if present, would generally not be threatened by off-shore oil and gas exploration/development activities).

Federal and state regulation and management policies require agencies, or their permittees, to complete a cultural resources survey before any undertaking occurs (i.e., a ground-disturbing activity, such as well drilling, construction of infrastructure or the construction of buried pipelines) not only on state and Federal lands but on lands that may be affected by the issuance of a Federal permit. BLM's guidelines and policies require that all effects to any cultural resources identified during surveys must be mitigated to the satisfaction of the land manager and the SHPO. Lease stipulations and ROPs developed for the action alternatives would minimize or prohibit exploration and development activities near major rivers, reducing the likelihood of impacts to cultural resources.

4.7.7.12 Subsistence

The Iñupiat people of the North Slope of Alaska have created, over the span of their history, a set of tools, behaviors, and cultural values that enabled them not merely to survive, but to thrive and expand into much of the Arctic, from Greenland to Siberia. Only in the last 180 years has contact with Euroamericans gone from seasonal trading to long-term occupation, and only in the last 60 years have semi-nomadic Iñupiat settled into sedentary villages and been subjected to managed hunts and the cultural pressure of Euroamerican dominance of commerce, government, and media. The central conflict for the Iñupiat on the North Slope, since the beginning of prolonged contact with Euroamericans, has been the use and control of lands, competition for renewable resources, and the efforts by Euroamericans to impose changes in the culture, lifeways, and behavior of the Iñupiat through regulation. Since the mid-19th century, the Iñupiat have adapted to external pressures (e.g., commercial whaling, trapping, reindeer herding, military construction, oil and gas exploration and development) and regulatory actions (e.g., state and Federal regulations and International Whaling Commission quotas; see **section 3.4.2**). The following discussion addresses key events (past, present, and reasonably foreseeable future) and the impacts that these key events have had on subsistence activities over time and could have in the future. Despite the past pressures for change, what remains constant is the value of maintaining a relationship with the land and resources of their forefathers through hunting and gathering activities and associated kinship and sharing, reinforcing the importance of subsistence to the Iñupiat people of the North Slope.

4.7.7.12.1 Past and Present Effects and Their Accumulation

Prior to sustained contact between the Iñupiat of the North Slope and Euroamericans, the Iñupiat were a highly mobile, geographically widespread, and technologically capable people who lived in dispersed, small communities based on family and social connections. They harvested local resources as needed and as available, with large numbers of people aggregating at certain points along the edges of the sea ice for the harvest of bowhead whales on their spring and fall migrations. Once a sufficient number of whales were harvested, they held a giant festival and feast, dividing whale products among participants, and then dispersed throughout the landscape again. This pattern continued into the 19th century, with intermittent contact with Russian, American, British, and Norwegian traders, explorers, missionaries, and government representatives. This contact intensified when commercial whaling north of the Bering Strait began in the 1850s (SRBA and ISER 1993).

With the advent of commercial whaling in the Pacific Ocean, European and American whaling ships worked further north, passing through the Aleutians in the mid-19th century, sparking a large number of independent people and companies harvesting marine mammal resources in the area. Commercial whaling north of Bering Strait lasted approximately 60 years, and introduced a number of impacts to the people and resources of the North Slope. Among these impacts were disease; the introduction of new foodstuffs, including flour, sugar, coffee, and tea; the increased availability of alcohol and tobacco; ongoing efforts at acculturation of the Iñupiat through missions and government schools; and efforts to centralize and make sedentary the highly mobile populations of Iñupiat. The failure of commercial whaling by 1910 coincided with a depletion in the number of whales available for harvest, making the ongoing subsistence harvest difficult for the Iñupiat remaining along the Arctic coast. Further complicating subsistence whale harvest was a decrease in the Iñupiat population due to disease, accidents, and poor health care. Iñupiat and whale populations gradually recovered during the 20th century. Following a reduced presence of Euroamericans in the beginning of the 20th century, due to the collapse of commercial whaling, the Iñupiat returned to their highly dispersed way of life, with additional emphasis on fur trapping and reindeer herding as a source of money to buy Euroamerican goods they desired.

In the 1920s, the establishment of the Naval Petroleum Reserve and subsequent exploration activity marked the beginning of resource extraction activity in lands occupied by the Iñupiat of the North Slope. World War II increased the need for oil for naval vessels and industry, and began a period of intensified exploration and drilling activity on the North Slope. Lucy Ahvakana described her experiences during this period in scoping testimony for Lease Sale 170 in 1997:

> When I was married to my first husband, we had a trading post in Foggy Island and Beach Pine, my first husband and I. We always go back and forth, trade, foxes, furnishing the food for Eskimos. Trappers live here. All of us -- a lot of us didn't get a chance to go to school. No school up here. You -- BIA didn't have enough money to put a school up here. They were trying to. And then we heard this oil company is coming. I moved to Barrow and these expeditions -- these looking for oil, Navys came. We went to Barrow. My husband said I had to go to Barrow to get my kids to school. So when we went there, we saw a bunch of barges. I thought it was Japanese invaded the Barrow. We were scared. And my stepdad went to shore. They seemed peaceful. We asked them, "What's going on?" The Navy's up here. They are looking for oil 1945. There were eleven

> barges. I know that Captain John Bablin, Sr., was the navigator for them. I moved to Barrow at that time.

Ms. Ahvakana's testimony continued to describe an indigenous person's view of the changes brought by the introduction of oil and gas exploration and development to a remote and technologically isolated population. The Bureau of Indian Affairs was responsible for educating and promoting the welfare of the Iñupiat people, as well as building a hospital and a school in Barrow. By 1950, the Bureau of Indian Affairs was requiring families with school age children to relocate to population centers (e.g., Barrow) so that the children could attend school. Construction of a hospital and churches at Barrow also encouraged North Slope residents to settle there. Children were sent outside to boarding schools, including Chemawa in Oregon and Mt. Edgecumbe in Sitka. The children that returned from these boarding schools often became spokespeople for the community and interposed themselves between the forces of development and the conservation of traditional ways of life. Some Iñupiat returned to traditional harvest areas seasonally, and in the early 1970s, following the passage of ANCSA, many traditional use areas were permanently resettled (e.g., Nuiqsut and Atqasuk). The events of this time period caused the formation of administrative offices (e.g., Alaska Federation of Natives, NSB).

During the mid-20th century, the Department of Defense contracted for the construction of DEW-line and WACS sites on the North Slope as part of a pan-Arctic curtain of radar coverage and communications systems that spread from Greenland to the Aleutians. North Slope residents were no longer allowed to hunt near these locations, all of which were situated at or near important subsistence or residence sites. Barter Island, the site of a trading fair and several camps, drew Iñupiat people to settle there for jobs, though the site was built on the remains of several historic houses and graves. Operation of these sites by the military, and later contractors, resulted in contamination of the surrounding area with fuel, oil, antifreeze, and other chemicals, which led to avoidance of these areas by subsistence harvesters concerned about chemical contamination.

Postwar oil exploration and the sustained contact with Euroamericans, brought by activities associated with oil and the Cold War, resulted in additive impacts on subsistence resources, harvest patterns, and users. The establishment and enforcement of state and Federal game regulations affected harvest activities and patterns (e.g., 1961 duck harvest protests in Barrow). These events encouraged the development of indigenous means of countering regulatory efforts dictated from outside the region and gave some voice to the Iñupiat people in defending their interests and promoting their causes (e.g., Alaska Federation of Natives in 1967 and Alaska Eskimo Whaling Commission in 1977). Out of these conflicts arose the first calls for scientific research into the peoples and lifeways of the Arctic, often based from facilities built by the military, such as the Naval Arctic Research Laboratory (NARL). Leasing of the offshore continental shelf areas for oil and gas exploration required further study, including study into the use of subsistence resources. These events also contributed to the organization of the communities in order to effectively address the issues brought up by development pressure, and to defend the rights of the Iñupiat people to maintain their way of life while incorporating the aspects of Euroamerican technology and culture that they found valuable. According to Worl, writing in one of the early research repots of contemporary subsistence uses by Iñupiat people, the "fate of subsistence lies not so much at the level of the hunter pursuing his game, but rather at the level of external pressures impacting his environment and regulatory actions that restrict his subsistence pursuits" (NSB 1980).

The most intense oil and gas development activity, and increased impacts to subsistence activities, occurred during the 1970s and early 1980s (e.g., development of the Prudhoe Bay and

Kuparuk oil fields, construction of TAPS and the haul road, and construction of a large portion of the roads, drilling pads, gravel sources, collector pipelines, and production facilities). In part, increased oil and gas exploration and development activity prompted the NSB to initiate the TLUI (NSB 1980), a repository for information on historic sites and present land use (e.g., hunting camps and cabins). Oil and gas development in the Prudhoe Bay and Kuparuk areas discouraged Nuiqsut residents from using the eastern portions of their traditional harvest areas (Pedersen et al. 2000, ADFG Division of Subsistence 2001, SRBA 2003b). Additionally, bowhead whaling quotas instituted by the International Whaling Commission resulted in the establishment of the Alaska Eskimo Whaling Commission.

Over the last 30 years, the Iñupiat have participated in public hearings for various industrial activities (e.g., lease sales, project scoping). During these hearings, the Iñupiat have consistently stated that they are concerned about the cumulative effects of industrial activities in their traditional subsistence use areas. They have noted the decline of fish populations caused by seismic activities, the diversion of caribou from traditional migration routes and calving areas caused by an increased number of low flying aircraft, the disruption of caribou movements by low pipelines, the ending of use of traditional harvest areas due to the avoidance of industrial areas by hunters, and the fear of the consequences of oil spills on subsistence resources. The specific experience of oil spills in the ocean were described by several elders due to the extent of the damage caused by an incident in the 1940s; described below is Thomas Brower's testimony for the 1975 Beaufort Sea hearings in Barrow:

> …I'm touching on this because of the fact that in 1944 or 45 when the Navy first came into this area, one of their tankers hit the bottom of the ocean, north of the point here, and they pumped 25,000 gallons of crude oil into the ocean; and as that thing scummed the ocean and started drifting toward these islands that you are talking about; it just hung in wide strips, some 40 to 50 feet wide along the edges of those islands. And all the ducks that came near it and the fur-bearing animals or the mammals (like the seal) went through it were soon blinded and thousands of them perished and I just don't know what happen to the fish that passed through those areas, but I'm pretty sure many of them died too.

This experience became the model for concerns about threats to subsistence species and continued use of these resources by Iñupiat people as oil development rapidly spread west from Prudhoe Bay. Some residents were profoundly concerned about impacts to marine resources, and so opposed any oil development in the marine environment. In the meantime, development on land proceeded to the area immediately east of Nuiqsut, raising concerns about continued subsistence access in the early 1980s. Bessie Ericklook noted in testimony at the 1979 Sale BF hearings her concerns about subsistence access to the east side of the Colville River and the effects of oil development on subsistence species:

> Trapping was abundant east of here. Now, we don't go over because of the oil field. Just recently, it is known that the foxes are very dirty, discolored and rabid in that area. Trapping is done elsewhere. We used to see grizzly bears around. Now, they are not around. Where's the caribou now? One summer when we used to walk miles looking for caribou, came across two dead caribou for unknown reasons. The animals have faced a change. We have faced a change since activity began. If there is to be further activity, the fish and the sea mammals will suffer and we will suffer too. We depend on the fish, wildlife and the birds, still, today. Oil development poses a threat to our lifestyle.

Impacts to subsistence caused by seismic exploration programs on the North Slope have also been observed for many years. Although seismic testing no longer uses dynamite on fish bearing lakes, Iñupiat blamed this activity for declines in fish numbers in the vast number of interconnected lakes and streams used by subsistence fishermen. Arnold Brower, Jr. stated in scoping testimony for the 1998 Northeast IAP/EIS scoping meetings a consensus opinion among Iñupiat subsistence hunters that seismic testing, even in its current refined form, deflects subsistence animals from the areas it operates in:

> Thank you Harry, I think I've heard that concern now from two other persons that directly told me that the existing seismic is already impacting subsistence hunters as we speak, that the seismic area has no game. The impacts, like Harry said, has scared and run the game off in one direction from that area already and numerous trips made by at least half a dozen hunters have attested that, that they've gone from the east side of the Ikpikpuk and Chipp River to the west side, where they're not there in that seismic area anymore. So these people have purchased gasoline and planned their trips just to find out that the seismic is in that area already and went up to those areas of normal hunting and the game is not there.

Subsistence is currently, and has been since the mid-19th century, part of a rural economic system, called a "mixed, subsistence-market" economy, wherein families invest money into small-scale, efficient technologies to harvest wild foods (ADFG 2000). Important subsistence resources have varied in abundance and availability over time, due to environmental variation and human activities, especially commercial exploitation. Iñupiat adaptations to external pressures resulted in intensified use of specific resources (e.g., bowhead whales, caribou, and furbearers) and a decline in the use of other species and resources (e.g. brant, goose and eider eggs, and long-tailed ducks). For muskox, reintroduced on the North Slope in the last 20th century, and moose, which expanded their range into the North Slope in the past half-century, regulatory restrictions have limited Iñupiat harvests. Over time, the Iñupiat experienced a growing reliance on an external market system to purchase introduced technological innovations to support subsistence activities (e.g., traps, boat motors, snowmachines). The constant advances in motorized transportation helped support the continued mixed economy and subsistence practices, partially mitigating the effects of concentrated populations and high levels of activity in particular areas by making travel faster and easier, although at greater cost in monetary resources. Avoidance of formerly utilized harvest areas due to industrial activity was made possible by motorized transportation, which allowed subsistence users to travel farther and faster than in the past. Increased institutionalization in response to increased industrial activity on the North Slope allowed increased Iñupiat autonomy and allowed the community to mitigate impacts with industry.

Cumulative effects from oil development are an important concern for North Slope residents. These concerns have been expressed in a number of different forums, including the 1998 Northeast IAP/EIS and Northwest IAP/EIS scoping meetings and hearings, scoping meetings for the Alpine Satellite Development Plan EIS, scoping meetings and hearings for the Northeast Amended IAP/EIS, and meetings held with North Slope residents in Anchorage, Nuiqsut, and Barrow during December 2003 and January 2004. Some of these concerns, as summarized in the Alpine Satellite Development Plan EIS (USDOI BLM 2004c), and brought up during public scoping meetings and other meetings with North Slope residents, are presented in Table 4.7-I.

Summary of Past and Present Effects and Their Accumulation

Prior to sustained contact between the Iñupiat of the North Slope and Euroamericans, the Iñupiat were a highly mobile, geographically widespread, and technologically capable people who lived in dispersed, small communities based on family and social connections. They harvested local resources as needed and as available. Beginning with commercial whaling in the 1850s, and followed by establishment of the Naval Petroleum Reserve and subsequent exploration activity that marked the beginning of resource extraction activity in lands occupied by the Iñupiat of the North Slope, the Iñupiat have had adapt to the "external pressures impacting his environment and regulatory actions that restrict his subsistence pursuits." Subsistence is currently, and has been since the mid-19th century, part of a rural economic system, called a "mixed, subsistence-market" economy, wherein families invest money into small-scale, efficient technologies to harvest wild foods. Over time, the Iñupiat experienced a growing reliance on an external market system to purchase introduced technological innovations to support subsistence activities (e.g., traps, boat motors, snowmachines). Avoidance of formerly utilized harvest areas due to industrial activity was made possible by motorized transportation. During this 150-year period, the Iñupiat have had to continually adapt to the constraints placed upon their subsistence activities and lifestyle by cultures other than their own. The effects of these constraints on the Iñupiat persist today and will accumulate with future effects on their subsistence resources and lifestyle.

4.7.7.12.2 Future Effects and Their Accumulation

On average, the populations of communities on the North Slope are anticipated to increase by 2% annually, resulting in a doubling of the current populations by about the year 2040 (see **section 4.7.2.1**). The increase in population means that, in the future, a greater number of resources will be harvested; however, current populations of primary subsistence resources, including caribou, bowhead whale, and fish, are sufficient to support this increase in human population. However, should outside forces, such as oil and gas exploration and development or global climate change, result in population decreases or shifts in range for natural resources, then these effects could result in decreased opportunity and less harvest when coupled with the estimated increased in human population.

Oil and gas development and leasing are likely to increase as compared to current conditions. Leasing and subsequent exploration and development are likely to occur not only in the Northeast, but also in the South Area, Northwest Area, and areas outside of the NPR-A (e.g. Point Thompson) (see Table 4.7-E for reasonably foreseeable oil and gas development). In addition, offshore exploration and development in the Chukchi and Beaufort seas is also expected to increase, with lease sales planned for the near future by Minerals Management Service and the State in these offshore areas. While it is unknown exactly how much of the offshore area will be leased in these future sales, several ship-based exploratory seismic operations have begun during the summer months, resulting in conflicts with marine mammal hunters, and concerns over the fall whaling harvest. Should a decrease in the harvest of marine mammals (e.g., bearded seal, ringed seal, walrus, etc.) occur, a corresponding increase in the harvest of land mammals and fish will occur to supplement the loss. Should the offshore activity lead to decreased success in fall whaling, this activity would result in major negative effects to subsistence use.

Planned development (e.g. Alpine Satellites) in the planning area would nearly encircle the community of Nuiqsut, making it necessary for subsistence hunters traveling in nearly every direction to pass through some kind of development en route to subsistence harvest areas. As

noted in public testimony for this amendment, Iñupiat hunters are particularly reluctant to use firearms near oil production facilities, roads, and pipelines, so they would be unlikely to harvest subsistence resources in these areas even if leaseholders did not object to harvester access. Subsistence users currently avoid the Kuparuk and Meltwater areas because of the physical barriers that pipelines and elevated gravel roads pose to winter snowmachine travel, and subsistence users have expressed concerns about hunting close to oil production and processing facilities, because of perceived regulatory barriers (Ahtuangaruak 2001). Development near Fish and Judy creeks and Kogru and Kalikpik rivers could interfere with access to areas where half of Nuiqsut's subsistence fish and caribou harvests take place (USDOI BLM MMS 2003). Development along the north side of Teshekpuk Lake, outside the areas currently closed to leasing, could deflect or divert caribou hunted in that area by Barrow, Atqasuk, and Nuiqsut residents (SRBA 2003b). If gas development occurs on the North Slope, its aboveground infrastructure would likely be avoided by subsistence harvesters, just as has been for oil development, perhaps even more so for hunters that may be concerned with a gas well blowout or a rupture of a gas pipeline.

Differing views are emerging on the North Slope regarding the effects of roads on subsistence. For example, some North Slope residents believe that roads could mitigate impacts on subsistence harvests from industry, could improve access to areas of the traditional subsistence range at times of the year when access would be difficult, would shift subsistence harvests to areas that are currently less utilized, and could change the mindset that has caused local subsistence users to avoid industry infrastructure. In addition, roads between Nuiqsut and infrastructure would allow Nuiqsut residents to live in town while employed by the oil and gas industry, thus allowing the worker to spend time with family and continue to harvest subsistence resources. On the other hand, roads could have a detrimental effect on traditional patterns of subsistence harvests and resource availability. For example, a new road would increase access among Iñupiat and others to areas previously less utilized and would change the character of that area and could deflect subsistence resources and interfere with nesting waterfowl. Additionally, roads that increase access would result in increased competition between users (both local and non-local).

Oil and gas production facilities operating in subsistence use areas could result in the contamination of subsistence foods, particularly fish, caribou, and marine mammals. Seismic exploration, exploratory drilling, and overland moves in the winter would continue to affect wolf and wolverine harvests. In the past, hunters observed these animals avoiding industrial activity areas, thus reducing their availability to Nuiqsut and Barrow hunters (Brower 1997). Harvest in these areas would require increased effort, risk, and cost on the part of subsistence users who pursue these animals for traditional clothing and crafts, as well as trade and sale of the hides. Oil and gas production facilities operating in subsistence use areas could cause the contamination of, or perceived contamination of, subsistence foods, particularly fish, caribou, and marine mammals. The numbers of foxes, brown bears, seagulls, and jaegers could increase, as these scavengers are habituated to human activities and food, and their predation on nesting waterfowl could increase as well (Burgess 2000). This increased predation on nesting birds, eggs, and fledglings could result in local resource declines, which could impact bird harvesting in communities on the North Slope, in Northwestern Alaska, and in the Yukon-Kuskokwim Delta.

In the past, oil and gas activities have deterred subsistence users from using their traditional subsistence use areas. The continued expansion of this activity across the ACP from Prudhoe Bay westward could increase the area considered off-limits by resource users, deflect or divert important subsistence resources from their normal routes, and require users to travel farther to

harvest subsistence foods (IAI 1990a). If commercial gas production occurs on the North Slope, it is likely that more infrastructure will be developed in the foothills area, where petroleum accumulations generally are more gas-prone, thus increasing the area that subsistence users are likely to avoid and the habitat for subsistence species that may be impacts. The continued increase in developed area would reduce the amount of suitable lands available for Nuiqsut residents to harvest necessary subsistence resources away from oil and gas facilities. If permanent facilities were constructed in the planning area, Nuiqsut hunters could be compelled to travel very long distances to harvest subsistence resources at a greater cost in terms of time, fuel, wear and tear on people and equipment, and lost wages.

Table 4.7-I. Summary of Traditional Knowledge/Local Knowledge

Resource Category	Summary of Effects and Locations	Testifier
Physical Characteristics		
Aquatic Environment (water resources; surface water; estuarine waters and water quality; marine water quality; flooding regime; and ice conditions.)	*Comment*: As a result of past action the Itkillik River, which was once clear, is now a rusty color. *Effects*: Decreased water quality and a lack of fish in the Itkillik River, and less fish for subsistence use. *Area*: Itkillikpatt and the Itkillik River.	Bessie Ericklook, 1979 Beaufort Sea Lease Sale, public hearing in Nuiqsut.
	Comment: Fresh water river levels near Nuiqsut are decreasing and rivers are getting shallower and shallower each year. *Effects*: Lower fish population and less fish for subsistence use. *Area*: Nuiqsut and surrounding rivers.	Flora Ipalook, 1979 Beaufort Sea Lease Sale, public hearing in Nuiqsut.
	Comments: Loss of 2 to 3 feet of water in area lakes especially Shinmar Rock; level went down to 5 to 6 feet and therefore it cannot support any more fish. *Effects*: Less fish present due to decrease in water levels and increase in noise, and less fish for subsistence use. *Area*: Shinmar Rock.	Arnold Brower, Sr., 1976 Federal Energy Hearings, public hearing in Barrow.
	Comment: Lakes and rivers are shallower than in past. Streams and rivers that shoot off of Tsukpuk Lake use to be navigable by boat but they can't even go on them. *Effects*: Decreased access; reduced fish populations; less fish available for subsistence use; and less available area for hunting and fishing. *Area*: Tsukpuk (Teshekpuk Lake).	Daniel Leavitt, 1979 Beaufort Sea Lease Sale, public hearing in Barrow.
	Comment: All drilling operations consume a lot of water. The same thing will happen to the Sagavanirktok like it did to the Sagavanirktok River; it ran completely dry twice in 1 year. *Effects*: Less animals and fish in area. *Area*: Sagavanirktok River.	Raymond Neakok, 1982 National Petroleum Reserve – Alaska, subsistence hearing in Barrow.
	Comment: A combination of built up ice and snow drifts and water rising with the tide causes area flooding. *Effects*: Flooding to 12 miles up river causes danger for those with a dog team or on snowmachine, and less accessible area. *Area*: Howuerenokto and Ocean Point.	Nuiqsut Whaling Captains Meeting, 1996 Northstar EIS Project.
Atmospheric Environment (climate and meteorology; air quality; and existing ambient air quality)	*Comment*: High winds and larger than average swells. *Effects*: Increase in swells, which inhibited ability to travel to and from subsistence area. A decrease in subsistence due to decrease in safe travel. *Area*: Cross Island.	Archie Ahkiviana, 2001 Liberty Project, public hearing in Nuiqsut.

Table 4.7-I. Summary of Traditional Knowledge/Local Knowledge (Cont.)

Resource Category	Summary of Effects and Locations	Testifier
Atmospheric Environment (Cont.)	*Comments*: She (former health aid and physicians assistant) has noticed an overwhelming increase in asthma patients. The village makeup has not changed, still mostly Inupiaq. The most overwhelming issue was that the oil development around the community had increased and gotten closer. The worst nights were nights with many natural gas flares, as they release particles and some infiltrate the ground. We are seeing changes in the caribou and fish leaving them with lesions and tumors. Helicopter activity has diverted caribou away from us during hunting/subsistence gathering. *Effects*: Burning of natural gas and petroleum products has increased risk for respiratory problems in local residents. Increase in noise due to air traffic spooks caribou herd thus decreasing amount present in area. Infiltration of particles has caused disease in animals. *Area*: Nuiqsut and immediate surrounding areas.	Rosemary Ahtuangaruak, Mayor, 2003 Alpine Slope Development Plan, public hearing in Nuiqsut.
Biological Resources		
Fish	*Comments*: Use of explosives has killed or damaged many fish under the ice (traditional methods of harvesting involved using a hammer to strike the ice creating a noise killing the fish). *Effects*: Smaller fish population due to increase in noise and less fish for subsistence use. *Area*: Finmore Rock, Sitkulik and the Tripp River area.	Arnold Brower, Sr., 1976 Federal Energy Hearings, public hearing in Barrow.
	Comment: Use of explosives and compressors, especially in the winter months, has killed off or caused the relocation of those fish in local rivers and lakes. A method used by his father to gather fish involving pounding on ice to kill fish then drilling an opening downstream to gather the fish is no longer a feasible means of collection for him. Lakes where the fish are inland freeze over in the winter and they die due to lack of water. A compressor which sends off a very loud noise and vibrations can also kill a lot of fish. *Effects*: Decreasing fish population. They are no longer able to use methods passed down through generations for harvesting fish. *Area*: Rivers in the area between Barrow/Nuiqsut to Anaktuvuk Pass.	Joash Tukle, 1982 National Petroleum Reserve – Alaska, subsistence hearing in Barrow.

Table 4.7-I. Summary of Traditional Knowledge/Local Knowledge (Cont.).

Resource Category	Summary of Effects and Locations	Testifier
Fish (Cont.)	*Comments*: We had some good fishing grounds up there and this fall we hardly even caught any. After the PET-4 seismograph party went through the depth of the lake is a little over 8 feet and a few blasts would clean the whole thing up. Traditional methods of hitting the ice then harvesting them out of the river downstream proved ineffective. *Effects*: Fish were not present following blasting and seismic activity and indirect effects as less fish available for subsistence use. *Area*: Area not specified.	Charlie Edwardson, 1976 Federal Energy Hearings, public hearing in Barrow.
	Comment: In an area where drilling had occurred, a net was placed in the lagoon near the ocean where my dad use to catch Arctic char. Even though we had the net there overnight we did not catch any fish. *Effects*: Fish population has declined in areas where drilling has occurred and less fish available for subsistence use. *Area*: Prudhoe Bay.	Jenny Ahkivgak (Okkingak), 1982 National Petroleum Reserve – Alaska, subsistence hearing in Barrow.
	Comments: Markers of the sounders that had been placed near the river. From that time on, the fishes in that river changed and are not there anymore right now. Sounders are killing them or driving them to the bottom of the stream. *Effects*: Fish were not present following sounding and less fish for subsistence use. *Area*: Area not specified.	Noah Itta, 1982 National Petroleum Reserve – Alaska, subsistence hearing in Barrow.
	Comments: Since the use of dynamite in the river, there have been fewer and sometimes no fish found. They also disturbed the garden where they live off of. *Effects*: Fish not present after blasting events (up to 3 years after) and less fish available for subsistence use. *Area*: Area not specified.	Noah Itta, 2001 Liberty Development and Production Plan, public meeting in Nuiqsut.
	Comment: Fished in the Fish Creek area for Arctic cisco with mother (2 generations), since start of Alpine few years ago, hardly any fish to be caught in same area. *Effects*: Less fish in Fish Creek area. An indirect effect is less fish available for subsistence use. Area: Fish Creek, Nuiqsut, and surrounding areas.	Jimmy Nukapigak, 2003 Alpine Satellite Development Plan, public hearing in Barrow.

Table 4.7-I. Summary of Traditional Knowledge/Local Knowledge (Cont.)

Resource Category	Summary of Effects and Locations	Testifier
Fish (Cont.)	*Comments*: CD-6 is close to Fish Creek area where they fish in the summer. When they can't get fish in the Nigliq Channel they slide over to the other channel. It has lots of fish and they taste better than Colville fish. *Effect*: Putting in CD-6 could possibly disturb area and effect population of fish in the area historically and currently used for fishing. *Area*: Around proposed CD-6 and Nigliq Channel area.	Frank Long, Jr. 2003 Alpine Satellite Development Plan, public hearing in Nuiqsut.
Birds	*Comments*: In Inigok where a lot of drilling took place, bones were seen from birds that have been killed from the stuff they leave behind in the hole. Wildlife and waterfowl dying from contaminants being left after having conducted drilling activity. *Effect*: Contamination of waterfowl and wildlife resulting in death and steady decrease in migratory bird population. *Area*: Upulatook near Nuiqsut; Inigok.	Thomas Brower, Jr. and James Aiken, Sr., 1997 1998 Northeast IAP/EIS, scoping meeting in Atqasuk.
	Comment: There's a lot of activity out there, and occasionally we have mortality events in either fish, caribou or waterfowl, and these essentially go unaddressed. *Effect*: Increased mortality likely associated with increased development and human activity. *Area*: Area not specified.	Todd O'Hara, 2003 Amended IAP/EIS, scoping meeting in Barrow.
Mammals (terrestrial and marine mammals)	*Comments*: Seismic activity is displacing the animals. While hunting wolverines, which were being tracked, they had just been scared away from where activity (seismic) was occurring. There are no furbearers except for the foxes; did not see wolverines. *Effects*: Normal movement of animals is affected by activity making hunting and tracking more difficult and decreasing the number of available wolves and foxes for subsistence use. *Area*: Southside of Teshekpuk up in Pikes dunes and up the Ikpikpuk River.	Harry Brower, Jr., 1997 1998 Northeast IAP/EIS, scoping meeting in Barrow.
Social Systems		
Economy	*Comments*: Being a 3rd generation since pre-contact of Western civilization, they are faced with the fact they must either subsist off the land or take a 9:00-5:00 job. Cannot totally exist on subsistence anymore. *Effects*: Lifestyle drastically different than the way of their forefathers. Can no longer subsist off of the land and must work for the oil companies. Most are not qualified and jobs are short lived. *Area*: Barrow.	Sheldon Bogenrifle, 1982 National Petroleum Reserve – Alaska, subsistence hearing in Barrow.

Table 4.7-I. Summary of Traditional Knowledge/Local Knowledge (Cont.)

Resource Category	Summary of Effects and Locations	Testifier
Economy (Cont.)	*Comments*: Qualifications have changed for those natives who desire to work for oil related companies. In the beginning, the only qualification was that you pass the UA, now to get a regular labor job or driving job you need a clean UA, a driver's license or a CDL, unrestricted, and NSTC card. *Effects*: Fewer are qualified or eligible for employment through the oil industry. Less available money for those living in the villages without qualifications (who are no longer able to completely subsist). *Area*: Village of Nuiqsut.	Bernice Kaigelak, 2003 Alpine Satellite Development Plan, public hearing in Nuiqsut.
	Comment: We face the highest unemployment rates today, even though we can see the Alpine oil field just 7 miles away from Nuiqsut. *Effect*: Limited economic benefits to local communities as a result of development nearby. *Area*: Area not specified.	Isaac Nukapigak, 2003 Amended IAP/EIS, scoping meeting in Nuiqsut.
Subsistence Harvest and Uses	*Comments*: The continuous development from the east going west has heavily impacted some of their hunting grounds. She is also very concerned of future development because more infrastructures are being placed, which will divert our hunting grounds, make our hunting game that much further out to try to harvest. *Effect*: Reduction in subsistence harvest opportunities. Longer distance and increased effort required to obtain harvests. *Area*: Area not specified.	Annie Lampe, 2003 Amended IAP/EIS, scoping meeting in Nuiqsut.
	Comments: We're going further and further inland to hunt caribou, but when they do come around our area, it's a blessing and a curse because a lot of these animals are sick. And then when you don't catch what you need, you have to rely on the income that comes in. *Effects*: Increased effort required to obtain harvests. Decrease in the quality of local harvests. *Area*: Area not specified.	Big Bob, 2003 Amended IAP/EIS, scoping meeting in Barrow.
	Comments: The residents of our communities rely upon these resources for the sustenance of our families. The cost of obtaining western staples is often out of reach of many families. The health of our community is dependent upon our resources. Any activity that causes changes to our harvesting of the subsistence resources will impact upon our families. The sharing of our resources with our extended families ripples down with losses for them also. *Effects*: Reduced community health. Effects beyond the hunters themselves. *Area*: Area not specified.	Rosemary Ahntuangaruak, 2003 Amended IAP/EIS, scoping meeting in Nuiqsut.

Table 4.7-I. Summary of Traditional Knowledge/Local Knowledge (Cont.).

Resource Category	Summary of Effects and Locations	Testifier
Land Uses and Coastal Management (land ownership; land use; coastal management; and the NSB Land Management Program)	*Comments*: After catching a musk-ok he was taken to court for being inside the industry boundary. Must now fight in court for harvesting in certain areas. *Effects*: Freely hunted subsistence areas are now trespassing on oil company land in order to reach the same areas restrictions on land use. Less muskox due to land use/ownership restrictions. *Area*: Area not specified.	Arnold Brower, Jr., 1998 1998 Northeast IAP/EIS, public meeting in Atqasuk.
	Comment: Open areas are now impassable due to dynamite left behind and wires scattered over the area. *Effects*: Change in use of land and less land to subsist from. Smaller amounts of available animals for subsistence harvest. *Area*: Area not specified.	Ruth Nukapigak, 1979 Beaufort Sea Lease Sale BF, public hearing in Nuiqsut.
	Comment: Her grandparents had a sod house and a cellar in Prudhoe Bay; now, they are unable to even access the site. They have no right to it even though their ancestors were there before the oil fields were there. Effects: Loss of access and previously owned land to oil industry. Area: Unspecified; Unspecified; Prudhoe Bay.	Sarah Kunaknana.
Transportation (road systems; aviation systems; marine transportation systems; pipeline systems; ice roads and platforms; winter Rolligon travel; and Alaska Railroad Corporation)	*Comment*: In order to cross the pipeline sometimes it is necessary to travel up to 10 miles off course. *Effects*: Longer travel time; indirect effect-increase in disturbed area due to having to travel off previously disturbed paths. *Area*: Nuiqsut area.	Thomas Napageak, Leonard Lampe, and Arnold Brower, 1997 1998 Northeast IAP/EIS scoping meeting in Nuiqsut.
Hazardous Materials/ Environmental Justice	*Comment*: As witnessed and experienced when working for the oil companies, toxic muds and caustic sodas are being dumped into the rivers and oceans. Most of the abandoned oil rigs I have worked on, the toxic muds are put in good little cubes, about 5,000 square yards of toxic muds go uncovered. The wastes are accumulating. *Effects:* Accumulation of toxic materials and waste. Indirect effects as animals are exposed to these hazardous materials. *Area*: Unspecified.	Raymond Naekok, 1982 National Petroleum Reserve – Alaska, subsistence hearing in Barrow.

Table 4.7-I. Summary of Traditional Knowledge/Local Knowledge (Cont.)

Resource Category	Summary of Effects and Locations	Testifier
Hazardous Materials/ Environmental Justice (Cont.)	*Comment*: When he was a boy, in his hometown during the springtime oil companies would clean out their silt and place the oils outside. Birds would stick to the oil and become unable to fly, eventually dying. *Effects*: Birds dying from inability to escape from oil exposed to the environment. Less birds for hunting and subsistence. *Area*: Area not specified.	Laurie Kingik, 1982 National Petroleum Reserve – Alaska, subsistence hearing in Barrow.
	Comment: And these construction outfits, they bring in the old equipment, old run down—some of them older than I am, and when they break, the oil gushes out. It sprays all over. *Effects*: Release of oil to the environment. *Area*: Area not specified.	Big Bob, 2003 Amended IAP/EIS, scoping meeting in Barrow.
Caribou	*Comments*: Seismic testing involving dynamite is affecting caribou who consume the blasting powder; causes rabid behavior and effects on the animals. Caribou are affected by amount of waste materials. *Effects*: Poisonous powder used in blasting is being eaten by caribou thus decreasing well population and waste materials attaching to caribou (wires). Indirect effect is less healthy caribou for subsistence use. *Area*: Area not specified.	Raymond Neakok, 1982 National Petroleum Reserve – Alaska, subsistence hearing in Barrow.
	Comment: The pipeline from Oliktok to Kuparuk has caused the displacement of caribou from Cross Island to Teshekpuk. Few caribou have are crossing under pipelines and as a result there is displacement of caribou in the villages. *Effects*: Less caribou present following installation of pipeline. Less caribou available for subsistence use. *Area*: Oliktok to Kuparuk, from Cross Island to Teshekpuk.	Frederick Tuckle, Sr., 2001 Liberty Development and Production Plan, public hearing in Barrow.
	Comment: The 5 feet pipeline height had changed the caribou migration pattern due to past oil and gas developments. *Effects*: Disruption of caribou migration. Disruption of subsistence harvest and more effort required to harvest caribou. *Area*: Area not specified.	Isaac Nukapigak, 2003 Amended IAP/EIS, scoping meeting in Nuiqsut.

Table 4.7-I. Summary of Traditional Knowledge/Local Knowledge (Cont.)

Resource Category	Summary of Effects and Locations	Testifier
Noise	*Comment*: Not far from the Nuiqsut site they are conducting wildlife surveys by air and by foot creating an enormous amount of noise that upsets, disrupts, and displaces perhaps some of their only opportunity to go get their game, especially caribou in the area are scared and may run off because of these impediments that arrive are not natural. Hunters must go further to gather game. *Effects*: Fewer caribou present following activity and surveys; thus, fewer caribou available for subsistence use. *Area*: Colville River Delta to the east side by Ulumniak.	Ruth Nukapigak, 1998 1998 Northeast IAP/EIS, public hearing in Nuiqsut.
Visual/Aesthetic	*Comment:* Flames out on the project oil platforms are very close to the whaling base of Nuiqsut called Cook Island so concerns on the migration and impacts to whales exist. Flames spook both the whales and crews who are harvesting whales for subsistence. *Effects*: Fewer whales in the area due to flashing gas flares. Increases danger for subsistence hunters. *Area*: Cross Island	Leonard Lampe, 1996 Northstar EIS Project, Nuiqsut public scoping meeting.

The International Whaling Commission sets the quota for the number of bowhead whales that Alaska Eskimos may harvest. This quota is based on both the biological status of the bowhead whale stock, as well as the documented Alaska Eskimo cultural and subsistence need for bowhead whales. It is likely that the International Whaling Commission would perceive increased industrialization of the National Petroleum Reserve – Alaska and rest of the North Slope, including development of coastal staging areas, heightened interest in adjacent offshore areas, and increased oil spill risks, as placing increased pressure on the endangered bowhead whale population. As industrialization proceeds along the Alaska North Slope, it will increase noise, vessel traffic, and the potential for an oil spill in the Beaufort Sea. In response to concerns that noise, vessel traffic, and the potential for a catastrophic oil spill poses a threat to the feeding grounds of the western Pacific gray whales, the International Whaling Commission has already passed a resolution that the onset of oil and gas development programs is of particular concern with regard to the survival of this population. Because the North Slope is the fall migration path and feeding grounds of the bowhead whale, it is likely that the International Whaling Commission would seriously consider the effects of industrialization on the bowhead whale population. Although the International Whaling Commission is unable to directly control industrial activities, they are able to control the Alaska Eskimo subsistence harvest quota and could reduce this quota as a means of protecting the species confronted with the effects of increased industrialization. If the International Whaling Commission considers the threat of

industrialization large enough, it could reduce the Alaska bowhead whale quota to protect the stock. This quota reduction would have a serious subsistence and cultural effect on the Iñupiat communities of the North Slope as well as to the Iñupiat in other communities who receive whale meat from the harvest.

4.7.7.12.3 Global Climate Change

Changes to the environment and habitats of the North Slope resulting from climate change could seriously affect subsistence resources and resource users (ACIA 2004). Changes to species diversity, numbers and distribution of Arctic-adapted species, vegetation coverage and type, and the physical structure of the landscape itself could result from changes in climate regimes. Erosion of river banks and beach bluffs, resulting from the thawing of permanently frozen ground, could have severe effects on how subsistence practices are undertaken, as subterranean ice cellars for storing food harvested at remote places for later transportation to the village could collapse and cabins and camps could continue to be washed away. Erosion and climate changes could change water levels in rivers and streams, making transportation by boat and land more difficult, damaging or destroying infrastructure, and reducing water quality (e.g., turbidity, dissolved oxygen) until some waters are no longer are suitable fish habitat. Water flows would increase as glacier fed streams absorbed melting runoff and decline as the glaciers retreated, also changing water quality, fish habitat, and possibly damaging the river valley microhabitats along the north-south oriented rivers of the North Slope. Climate changes could reduce suitable browse for caribou and muskox, possibly shifting their range away from the communities or reducing their numbers. The same habitat changes may favor moose, which Iñupiat hunters perceive as less suitable as subsistence staples because they are solitary, require large ranges per animal, and do not predictably move in large numbers to specific areas, making it more difficult and energy intensive to harvest them. Due to their size, moose also require more effort to butcher, transport, and process than caribou and muskox (ACIA 2004). Climate change could result in a reduction in marine ice and a less safe ice edge, affecting spring marine mammal hunting, including Barrow spring bowhead whale hunting, polar bear hunting, and seal hunting.

Marine currents could be changed by the retreat or disappearance of the ice sheet, shifting some marine mammals much further offshore or to where the habitat is still available, perhaps as far as High Arctic Canada. Migratory waterfowl numbers could decrease, change their migration paths, or go extinct if key habitat was changed. Marine currents could change the distribution and habitats of anadromous and amphidromous fish, which are key subsistence resources for the communities. Warmer temperatures could also reduce habitat for freshwater fish, or change populations to those more suited to warmer waters. Rising sea levels could inundate low-lying coastal lands along the North Slope and change the salinity of surface and ground water, further changing fish and waterfowl habitats and subsistence resource uses. As the landscape becomes less hospitable for human occupation, people could move to new locations on the North Slope, leave the area for either urban Alaska or High Arctic Canada, or adapt to the new conditions with a combination of reduced subsistence resources and increased dependence on outside sources of food and supplies. As a result, community stresses would increase and traditional knowledge of the landscape, environment, and resources would be devalued if conditions changed rapidly. Reduced levels of stratospheric ozone could increase levels of UV exposure to northern peoples, lowering immune system function and increasing the likelihood that residents would suffer increased incidences of skin cancer and cataracts (ACIA 2004).

Effects to subsistence in the foreseeable future are primarily a continuation of effects from the last century. Changes in oil and gas exploration and development technology, as discussed in

section 4.7.4, *Advances in Technology*, could mitigate some of the effects observed in the past (e.g., population declines in fish as a result of seismic activity). Increased oil and gas activity and climate changes are likely to continue to affect subsistence activities. For example, additional losses of traditional subsistence harvest areas would occur and traditional subsistence resources may no longer be available for harvest (e.g., some species of migratory birds). Subsistence users would continue to travel farther to harvest resources, but are unlikely to cease subsistence harvests given the strong cultural continuity and value of subsistence activities.

4.7.7.12.4 Contribution of Supplemental Alternatives to Cumulative Effects

This cumulative analysis assumes that currently planned development in the planning area (e.g. Alpine Satellites) and winter exploration throughout the entire area would continue. Seismic exploration would occur in winter and would include the drilling of exploratory and delineation wells in areas not excluded by buffers. Exploration and development could originate from Inigok, Point Lonely, and the Umiat vicinity, and could encompass important subsistence harvest areas for moose, fish, caribou, birds, and furbearers, affecting subsistence users in Nuiqsut and to a lesser extent Atqasuk, Barrow, Wainwright and Anaktuvuk Pass. If permanent development is pursued in areas newly opened to exploration and leasing under the action alternatives, Iñupiat users are likely to avoid the area from 5 miles to 25 miles around those facilities for subsistence uses (Pedersen et al. 2000; Pedersen and Taalak 2001).

Allowing leasing and development of all or portions of the area north and west of Teshekpuk Lake under Alternatives B, C, and D would dramatically reduce the amount of undisturbed habitat to caribou, waterfowl, fish, and other subsistence species. Additionally, in opening this part of the planning area to leasing, infrastructure such as pipelines and CPFs developed in this area would make oil and gas development in the adjacent northeast portion of Northwest NPR-A and Beaufort Sea more likely in the foreseeable future. These effects to subsistence species would be greatest under Alternative C. Teshekpuk Lake would be deferred from leasing under Alternative D, thereby protecting waterfowl and other subsistence species that use the lake. In addition, surface occupancy restrictions on permanent facilities in caribou habitat protection areas and the Goose Molting Area would limit the amount of surface disturbance that could occur north and east of Teshekpuk Lake; these restrictions would reduce the likelihood of cumulative effects to subsistence resources. Under Alternative A, 600,000 acres would remain closed to leasing.

4.7.7.12.5 Conclusion

Oil and gas exploration and development activities on the North Slope have greatly impacted subsistence activities, as noted during public scoping testimony. In the planning area, exploration and development could originate from Inigok, Point Lonely, and the Umiat vicinity, and could encompass important subsistence harvest areas for moose, fish, caribou, birds, and furbearers, affecting subsistence users in Nuiqsut, Atqasuk, Barrow, Wainwright and Anaktuvuk Pass. Subsistence hunters traveling in nearly every direction from Nuiqsut would have to pass through some kind of development en route to subsistence harvest areas. Iñupiat hunters are reluctant to use firearms near oil production facilities and pipelines, so subsistence users would be unlikely to harvest subsistence resources in these areas. Aircraft have interfered with hunts by scaring game away from hunters, and the increase in air traffic by fixed-wing aircraft and helicopters would make this worse and over a much greater area if development goes forward. This issue has been raised several times by residents of Nuiqsut, who have also noted that oil and gas development is impacting traditional use areas and their ability to pass

on knowledge of subsistence resources in these area, and use of these resources, to their children.

Development along the north side of Teshekpuk Lake, outside the area closed to leasing in any given alternative, could deflect or divert caribou hunted in and near the area by Nuiqsut, Barrow, and Atqasuk residents in the summer and winter (SRBA 2003b). Numbers of animals available for harvest could be reduced through the slow destruction of species by habitat loss, predation, climate change, and disease. Diverting animals from their usual and accustomed locations, or building facilities in proximity to those locations, could compel resource harvesters to travel further to avoid development areas. Harvest of subsistence resources in areas further from the communities would require increased effort, risk, and cost on the part of subsistence users. Increasing the areas open for leasing and exploration would lead to development in previously closed areas, leading to concentrating subsistence harvest efforts in the undeveloped areas and increasing the potential for conflict over harvest areas within a community.

If gas development occurs on the North Slope, it is likely that development would occur in portions of the foothills, further expanding the areas subsistence users would likely avoid.

Offshore oil and gas exploration and development in the Chukchi and Beaufort seas could alter the migration of bowhead whales and other sea mammals, such as walrus and bearded seal, all of which are important subsistence resources for North Slope residents. These impacts would be devastating to North Slope communities should the changes in migration (i.e., further north beyond the ability of whalers/hunters to travel) should they reach the point of causing failed harvests, especially failed bowhead whale hunts. In addition, any reduction in the Alaska bowhead whale quota made in response to offshore activity by the International Whaling Commission would have a serious subsistence and cultural effect on the Iñupiat communities of the North Slope, as well as to the Iñupiat in other communities who receive whale meat from the harvest.

Climate change and the associated effects of anticipated warming of the climate regime in the Arctic could significantly affect subsistence harvests and uses if warming trends continues as predicted (NRC 2003, ACIA 2004). Every community in the Arctic is potentially affected by the anticipated climactic shift and there is no plan in place for communities to adapt to or mitigate these potential effects. The reduction, regulation, and/or loss of subsistence resources would have severe effects on the subsistence way of life for residents of Nuiqsut, Atqasuk, Barrow, and Anaktuvuk Pass. If the loss of permafrost, and conditions beneficial to the maintenance of permafrost, arise as predicted, there could be synergistic cumulative effects on infrastructure, travel, landforms, sea ice, river navigability, habitat, availability of fresh water, and availability of terrestrial mammals, marine mammals, waterfowl and fish, all of which could necessitate relocating communities or their population, shifting the population to places with better subsistence hunting and causing a loss or dispersal of community (NRC 2003, ACIA 2004).

4.7.7.13 Sociocultural Systems

The Iñupiat have developed sociocultural systems, including settlement patterns, kinship, leadership institutions, and cultural values concerning relationships with the land, as tools for successfully adapting to their Arctic environment. The following discussion addresses key events (past, present, and reasonably foreseeable future) and the impacts that these key events have had on sociocultural systems over time. This discussion focuses on sociocultural cumulative effects primarily involving changes in cultural values and social organization.

4.7.7.13.1 Past and Present Effects and Their Accumulation

Impacts to the sociocultural systems of the Iñupiat of the North Slope have occurred since the first direct interactions with non-Natives in the first quarter of the 19th century. Since that time, the Iñupiat have adapted to new technologies, new external pressures (e.g., commercial whaling, trapping, reindeer herding, military construction, oil and gas exploration and development), and regulatory actions (e.g., state and Federal regulations and International Whaling Commission quotas). (See **sections 3.4.2.3, *Traditional Iñupiat Settlement Patterns and Subsistence Use Areas*, and Appendix J.5, *Traditional Iñupiat Settelement Patterns and Subsistence Use Areas*** for further discussions of these interactions and external pressures.) Adaptations to these external pressures resulted in intensified use of specific resources (e.g., bowhead whales, caribou, and furbearers). Commercial whaling north of the Bering Strait began and ended in approximately 60 years, and introduced a number of impacts to the people and resources of the North Slope such as disease, the introduction of new foodstuffs (e.g., flour, sugar, coffee, and tea), the increased availability of alcohol and tobacco, ongoing efforts at acculturation of the Iñupiat through missions and government schools, and efforts to centralize and make sedentary the highly mobile Iñupiat populations. Over time, the Iñupiat experienced a growing reliance on an external market system to purchase newly introduced technological innovations to support subsistence activities (e.g., firearms, traps, boat motors, snowmachines). Missionaries arrived in the latter quarter of the 19th century to proselytize among the Iñupiat, operate federally-funded schools for the education and indoctrination of Iñupiat youth, provide some level of medical care, administer reindeer herding and other social experiments, and care for orphans whose parents had died in epidemics and accidents. The missionaries considered these efforts as necessary to mitigate the impacts of commercial whaling and prolonged contact with Euroamericans.

Commercial whaling ended by 1910, leaving whale numbers, as well as the Iñupiat population, depleted, and possibly resulted in the decreased availability of other subsistence species (e.g. caribou, moose, seals) and the extirpation of others (e.g. muskox). Fur trading became the main economic pursuit capable of earning the money needed to purchase American goods, such as sugar, tea, tobacco, flour, coffee, and lard, demanded by the Iñupiat. The Iñupiat, whose population was further devastated by the 1918 influenza epidemic, dispersed along the coasts and rivers, pursuing furs and a subsistence way of life until the Great Depression drove fur prices so low that fur trapping was no longer a viable pursuit. Subsistence whaling continued as a practice and as the center of social and political organization on the North Slope, and as the populations of whales and Iñupiat gradually recovered in the 20th century, resettled communities began to field discreet bowhead whale crews (e.g., Nuiqsut and Kaktovik).

With the establishment of the Naval Petroleum Reserve – Alaska in 1923, some initial exploration took place along the North Slope, but oil exploration and development did not commence fully until 1944, when the U.S. Navy and its contractors arrived to intensively explore and drill in the reserve. Following World War II, the U.S. Army constructed DEW-line sites and White Alice Communications System sites on the North Slope, often atop established Iñupiat camps and use areas, and North Slope residents were no longer allowed to hunt at these locations. In the late 1940s, the Bureau of Indian Affairs required families to relocate to population centers (e.g., Barrow, Anaktuvuk Pass) so that children could attend school. In addition, construction of a hospital and churches at Barrow also encouraged North Slope residents to settle there. Iñupiat harvesters and their families often returned to traditional harvest areas seasonally, and in some cases those without school-aged children never left the traditional areas. In the early 1970s, following the passage of ANCSA, many traditional use

areas and former villages were permanently resettled (e.g., Nuiqsut, Atqasuk, Kaktovik, and Point Lay).

By the mid-20th century, Iñupiat settlement patterns had changed significantly. The population became centralized into a few communities, when they previously had been spread in small family-based units across the North Slope sea coast, river banks, and lake shores, and only gathered into centralized locations for temporary, communal hunts (e.g. whales, caribou, molting birds), trading, and festivals. As the market economy and the need for cash for subsistence and survival have expanded, technological means for maintaining connections to the land have moderated the effects of gradually encroaching development along the North Slope. The limits of technology in mitigating the impacts of sedentism and oil development on subsistence activities have been reached. Few areas are out of reach for those with the wherewithal to purchase, maintain, and fuel the high-tech transportation equipment needed to access those areas. However, the expense of subsistence equipment and pursuing subsistence resources, time spent preparing for and on subsistence harvests, and wear and tear on subsistence equipment, restrict the ability of subsistence users to harvest adequate quantities in times of resource scarcity.

The cumulative effects of oil and gas development on sociocultural patterns over the last 50 years are hard to establish with quantitative precision given the lack of baseline data. As stated in **section 4.3.13, *Sociocultural Systems***, public testimony indicates that a relationship exists between oil and gas development and social stress or well-being (Ahtuangaruak 1997). One example of a study that is being conducted to explore this relationship is the MMS sponsored study that will analyze NSB residents' observations and perceptions about effects from past, present, and future oil industry activities and other forces of modernity on their lives and subsistence whale hunting activities (EDAW in prep). In addition, the NSB has submitted a grant request to the State of Alaska for a study of the cultural, social, and economic impacts to National Petroleum Reserve – Alaska subsistence communities resulting from current Arctic oil and gas exploration and production. The North Slope Science Initiative could also affect scientific research projects (Argonne National Laboratory 2004). Nonetheless, there is evidence that North Slope sociocultural systems have been subject to ongoing, additive, and synergistic cumulative impacts. Stress on North Slope sociocultural systems, which is generally underreported and inadequately documented, includes residents' inability to access traditional use areas, threats to resources/lifeways and to spiritual connection with the land, having to deal with multiple environmental impact assessments and other development processes, and being ignored or discounted by agency representatives. Long-term stresses would result in greater impacts to sociocultural systems. The possibility of a very large oil spill, and its effects on bowhead whales and other marine mammals, fish, and wildlife, is of great concern to residents, although no such spill has occurred on the North Slope. These stresses accumulate because they interact and are repeated with each new lease sale, EIS, development proposal, and facility expansion (NRC 2003).

Despite effects to sociocultural systems by oil and gas development, what has remained constant over time is the centralization of leadership with whaling captains and their wives, a continued cultural and nutritional dependence on and desire for subsistence foods, a continued reliance on sharing and kinship, a continued connection to family camps and land use areas, and the desire to have control over their communities' present and future. Whaling captains often are in positions of power in city, borough, and other institutions, and the institutions conform to the Iñupiat model of leadership and process. Subsistence foods are important for their nutritional value and their relatively low costs to the community, but most of all for the continued maintenance of the network of human and animal relationships, Iñupiat identity, and

the activity of hunting, processing, and sharing as an outlet for individual social stress and a means of reducing community stresses. The desire to have some control over the harvest areas they depend upon, and the stress resulting from development and activities that conflict with their values with no recourse, is a significant stressor to individuals and communities. Some of these conflicts can be mitigated, as in the case of oil and whaler's agreements. Conflicts that are perceived to pit the Iñupiat against agencies and corporations contribute to feelings of futility, powerlessness, and despair, and when coupled with subsistence harvest shortfalls failures, pervasive unemployment, overcrowding, and other issues could result in significant and serious sociocultural consequences (IAI 1990). In the event that whaling quotas were reduced, whales were deflected offshore to avoid marine and air traffic and noise, or a significant marine oil spill occurred, whaling could be reduced or stopped, undermining the primary structure of social organization, traditional authority, and political power in the communities. As stated in **section 4.3.13, *Sociocultural Systems***, NSB institutions, such as the school district that promotes the teaching of Iñupiat language and culture, the Arctic Eskimo Whaling Commission that negotiates with industry and the IWC to protect Iñupiat subsistence whaling interests, the NSB Department of Wildlife Management, and other regional and village Native corporations and organizations, have been working vigorously and quite successfully at preventing the weakening of traditional Iñupiat cultural institutions and practices. "Oil-Whaler Agreements" have lessened the impact of seismic and other industry operations on subsistence bowhead whale hunting at Cross Island (NRC 2003).

The encroachment of oil production facilities and infrastructure into areas formerly used for subsistence by the Iñupiat increases the difficulties faced by subsistence users in trying to provide culturally valued foods for their extended families. This encroachment includes the permanent oil infrastructure to the east, north, and west of Nuiqsut, as well as the winter exploratory drilling and seismic testing in Inigok and other staging areas. The cycle of oil exploration, development, and production activities, as it is conducted both offshore and onshore, has contributed to harvest shortfalls, a loss of cultural privacy, and challenge to traditional Iñupiat values. Frustration stemming from the inability to provide for the extended family or exercise control over external factors further stresses people who are exposed to these problems. Rosemary Ahtuangaruak, former mayor of Nuiqsut, testified in the 2001 hearings held for the Liberty project, the following:

> One of the biggest issues that affects our community is the loss of control. In addition to the loss of subsistence opportunities, the major severe impacts result from the petroleum development in other areas of the Arctic. It is the lack of control over these events experienced by the village. Nuiqsut residents state they are the last to find out what's happening to them. They are never asked or generally considered about the pattern or course of the industry's development. They are merely informed after major decisions are in place. They would not spend the money making these studies if they were not planning to develop them. So it's a moot issue, after the fact. You're coming for the meeting, but you're already spending the money because you know this project is happening. This perception causes enormous social stress and tension. It is reflected in the increased community social ills, such as the alcoholism, the domestic violence, and the drug abuse. Thus, existing and potential activities further exacerbate and destabilize stress and tension resulting from almost 20 years of petroleum activities in the region. And since development would complete the pattern surrounding our traditional whaling site, it poses the most significant and long-term adverse social and cultural impacts of all the development of the North Slope, the potential for permanent reduction and/or loss of subsistence reserves, and thus, the viability of the Iñupiat way of life.

In response to these types of social disruptions, the NSB, Alaska Eskimo Whaling Commission, regional and tribal governments, and village corporations have instituted efforts to foster and protect Iñupiat traditions. The BLM Subsistence Advisory Panel is tasked with investigating conflicts between subsistence activities and oil and gas development, and making recommendations to the lessee and the BLM for resolution to protect sociocultural values. Health and social services programs have tried to respond to alcohol and drug problems with treatment programs and shelters for abused spouses and families of abused spouses (USDOI BLM 2004c). Effective responses to other health issues, such as asthma, which is attributed by many local residents to exposure to increased pollution from oil field operations, in addition to a background of cold weather and other injuries and illnesses, suffer from funding shortages. Rosemary Ahtuangaruak testified the following during scoping for the Alpine Satellite Development Plan EIS (USDOI BLM 2004c):

> When I started as a health aide in 1985 I had one asthma patient. By the time I went to the University of Washington for my physician assistant certificate in 1989, I had 20 to 25. When I came back in '91, there were 35. When I quit in 2000, there were over 60. The village make-up has not changed; it is still mostly Inupiaq. What was contributing, the most overwhelming issue, was that oil development around the community had increased and gotten closer. The worst nights on call were nights with many natural gas flares occurring. We could see it in the flares or in the fields around us. They release particles and they travel to us. The chance of an inversion will affect us. An inversion is a bowl-like air trap with cold air trapped by warm air. Increased concentrations of particulate matter occurs during these episodes.

Additional information regarding the potential cumulative impacts to human health can be found in **section 4.7.7.19**.

Summary of Past and Present Effects and Their Accumulation

Impacts to the sociocultural systems of the Iñupiat of the North Slope have occurred since the first direct interactions with non-Natives in the first quarter of the 19th century. Since that time, the Iñupiat have adapted to new technologies, new external pressures, and regulatory actions. By the mid-20th century, Iñupiat settlement patterns had changed significantly. The population became centralized into a few communities, when they previously had been spread in small family-based units across the North Slope. The cumulative effects of oil and gas development on sociocultural patterns over the last 50 years are hard to establish with quantitative precision given the lack of baseline data. Nonetheless, there is evidence that North Slope sociocultural systems have been subject to ongoing, additive, and synergistic cumulative impacts, and that oil and gas development, the primary driver of change for the past 50 years, has contributed substantially to these impacts. Stress on North Slope sociocultural systems includes residents inability to access traditional use areas, threats to resources/lifeways and to spiritual connection with the land, having to deal with multiple environmental impact assessments and other development processes, and being ignored or discounted by agency representatives. Long-term stresses would result in greater impacts to sociocultural systems. The possibility of a very large oil spill, and its effects on bowhead whales and other marine mammals, fish, and wildlife, is of great concern to residents, although no such spill has occurred on the North Slope. These stresses accumulate because they interact and are repeated with each new lease sale, EIS, development proposal, and facility expansion.

4.7.7.13.2 Future Effects and Their Accumulation

Continuing oil and gas leasing and development, as well as on-going changes in the Arctic climate, will have impacts on Iñupiat sociocultural systems in the foreseeable future. Development is currently being considered for the northeast corner of the planning area (e.g. Alpine Satellites), and further exploration and delineation activity is ongoing in the leased areas south of Teshekpuk Lake. If oil and gas activities were to continue in areas already leased, Nuiqsut residents would be increasingly isolated from their subsistence resources and would be encircled by development, as stated by noted elder Ruth Nukapigak (1982) and others in the community. This problem could be exacerbated if gas development caused development in and out of the planning area to extend into the foothills of the Brooks Range. Cumulative effects could include changes to social organization, and impacts to cultural values and general community welfare (e.g., health and education). Changes to social organization could potentially occur as a result of changes in population, employment, subsistence harvest patterns, social bonds, and cultural values. In addition, the increase in income in NSB communities could potentially result in an increase in social problems, such as drug and alcohol abuse and violence, as well as increasing conflicts from wealth disparities.

Offshore exploration and development in the Chukchi and Beaufort seas is also expected to increase, with lease sales planned for the near future by Minerals Management Service and the State in these offshore areas. While it is unknown exactly how much of the offshore area will be leased in these future sales, several ship-based exploratory seismic operations have begun during the summer months, resulting in conflicts with marine mammal hunters, and concerns over the fall whaling harvest. Should the offshore activity lead to a considerable decrease in success in fall whaling, this activity would contribute to major negative effects to the North Slope Iñupiat peoples' identity, and could have culture-wide effects.

The abandonment of oil fields and the related loss of revenue would no doubt have serious effects on the entire state of Alaska. However, the collapse of commercial enterprise is seen as inevitable and is common over the history of the Iñupiat. Commercial whaling served the same markets as petrochemicals do today, and the Iñupiat survived by returning to the land. Fur trapping collapsed and the Iñupiat people adapted. Based on this historic demonstration of their resiliency, it would appear that the Iñupiat may be at less risk from the decline of industry than they are in the face of an expanding and unchecked industry. Nevertheless, worldwide data suggest a consistent pattern of marked increases in stress, social problems, and emigration under circumstances of sudden or severe economic depression. Data from Inupiat populations has shown that economic depression correlates strongly with epidemic rates of suicide (Travis 1985). In the event of oil field abandonment, the Iñupiat would likely be employed to assist in the removal and demobilization of the infrastructure, and would continue with their subsistence pursuits. Less than 10% of Iñupiat history has proceeded in contact with Europeans and Americans, and in those 200 years they have maintained their unique cultural identity as a people throughout the Arctic.

Not all sociocultural changes are negative. As is discussed in **section 4.7.2.1**, it is anticipated that there will be a doubling of the population on the North Slope by the year 2040. As long as the core Iñupiat values continue to be passed from generation to generation as they currently are, an increase in the Iñupiat population results in a strengthening of the culture as a whole. Positive impacts also come from higher incomes, better health care, improved housing, and improved infrastructure and educational facilities, although these impacts may primarily benefit younger individuals who are generally more accepting of change (NRC 2003). Iñupiat culture as an adaptive mechanism is a powerful means of self-directed social, political, and

cultural change capable of sustaining the Iñupiat through adverse circumstances as it has for centuries guided them through resource shortages, inter- and intra-group social conflicts, and environmental changes.

4.7.7.13.3 Global Climate Change

Climate change could cause changes to the environment and habitats of the North Slope that could affect subsistence resources and users, as discussed in **section 4.7.7.12, *Subsistence***. Changes in climate regimes could result in changes to species diversity, numbers and distribution of Arctic-adapted species, vegetation coverage and type, and the physical structure of the landscape. If the landscape becomes less hospitable for human occupation, people may move to new locations on the North Slope, leave the area for either urban Alaska or High Arctic Canada, or adapt to the new conditions with a combination of reduced subsistence resources and increased dependence on outside sources of food and supplies. Community stresses could increase as a result, and traditional knowledge of the landscape, environment, and resources would be devalued if conditions change rapidly, reducing the influence of experienced elders in the communities. Reduced levels of stratospheric ozone could continue to allow higher levels of UV exposure to northern peoples, lowering immune system function and increasing the likelihood that residents would suffer increased incidences of skin cancer and cataracts (ACIA 2004).

4.7.7.13.4 Contribution of Supplement Alternatives to Cumulative Effects

As noted above, continuing oil and gas leasing and development will have impacts on Iñupiat sociocultural systems in the foreseeable future. If oil and gas activities were to continue in areas already leased, Nuiqsut residents would be increasingly isolated from their subsistence resources and could be encircled by development. Cumulative effects could include changes to social organization, and impacts to cultural values and general community welfare (e.g., health and education). Changes to social organization could potentially occur as a result of changes in population, employment, subsistence harvest patterns, social bonds, and cultural values. In addition, the increase in income in NSB communities could potentially result in an increase in social problems, such as drug and alcohol abuse and violence, as well as increasing conflicts from wealth disparities.

Alternatives B, C, and D would open the northwest portion of the planning area to leasing. Infrastructure such as pipelines and CPFs developed in this area would make oil and gas development in the adjacent northeast portion of Northwest NPR-A and Beaufort Sea more likely in the foreseeable future.

These effects would be greatest under Alternative C, not only because it would result in a greater amount of surface disturbance than the other alternatives, but because the entire planning area would be available for oil and gas leasing and development. However, the amount of wealth, including income from royalties, taxes, and jobs, generated by oil and gas activity and available to residents of the North Slope would be greater under Alternative C than the other alternatives. The effects on wealth and subsistence resources would be least under Alternative A, while the effects on wealth and subsistence resources under Alternative B and Alternative D would fall between Alternative A and Alternative C.

4.7.7.13.5 Conclusion

Both additive and synergistic impacts to sociocultural characteristics of North Slope communities are associated with oil and gas exploration and development on the North Slope. Because of the primary dependence of Anaktuvuk Pass, Atqasuk, Barrow, Wainwright, and Nuiqsut residents on the subsistence caribou harvest from CAH, TLH, and WAH caribou, bowhead whaling offshore, and continued healthy fish, cumulative effects could potentially chronically disrupt sociocultural systems in the community, particularly in the case of bowhead whaling, around which the sociocultural system is based. Caribou hunting provides food and materials that support whaling. Seal hunting provides skins for Barrow's skin boat whaling in the spring and supplies meat for food. Fishing and bird hunting provide meat and fish for whalers as well as for the festivals, Nalukataq and Kivgiq, associated with whaling. These festivals are important social activities that unify the communities, reunite families, and maintain the continuity of the present with past practice and tradition.

Effects from industrial activities (e.g., noise, light, and chemical pollution), changes in human population and employment, and the accompanying changes in subsistence-harvest patterns, social bonds, and cultural values would be expected to disrupt community activities and traditional practices for harvesting, sharing, and processing subsistence resources, but they would not be expected to displace sociocultural institutions, social organization, or sociocultural systems. Funding cuts and reduced wage earnings would not likely reduce subsistence uses, but may require changes in seasonal round and longer periods of travel to get to subsistence harvest areas; however, these would more than likely resemble the pre-1950 pattern of residence and travel, and technology is available that could facilitate education services delivery via electronic means.

Health issues caused by persistent and short-term pollution could shorten life spans of elders, who are the key repositories of traditional and cultural knowledge in the communities. Health issues from increased injuries as a result of the need to travel further over rough terrain to support families with subsistence foods could reduce community involvement with employment, tax the community health infrastructure, encourage outmigration, and lead to increases in substance abuse and depression in those no longer able to participate in subsistence activities. Cuts in funding for services would increase the severity of the problem of delivery of health services as well as maintaining health and hygiene infrastructure (e.g. fresh water, sewers, and washeteria).

Because of impacts from climate change on long-standing traditional hunting and gathering practices that promote health and cultural identity, and considering the limited capacities and choices for adaptation and the ongoing cultural challenges of globalization to indigenous communities, North Slope peoples would experience cultural stresses as well as impacts to population, employment, and local infrastructure. The termination of oil and gas activity could result in the outmigration of non-Iñupiat people from the North Slope, along with some Iñupiat who may depend on higher levels of medical support or other infrastructure and services than may be available in a fiscally-constrained, post-oil production circumstance. If subsistence livelihoods are disrupted, Iñupiat communities could face increased poverty, drug and alcohol abuse, and other social problems resulting from a loss of relationship to subsistence resources, the inability to support a productive family unit, and a dependence on non-subsistence foods (Langdon 1995, Peterson and Johnson 1995, USGCRP 2000, IPCC 2001). As stated by Parson et al. (2001), "It is possible that projected climate change will overwhelm the available responses." It is also realistic to expect that some general assistance could be found to mitigate the losses of

nutrition, health, and income from diminished subsistence resources, but such assistance would likely have little effect in mitigating the associated social and cultural impacts.

4.7.7.14 Environmental Justice

Activities that impact subsistence resources and access to those resources could have a disproportionately high impact on minority and low-income communities. Alaska Iñupiat Natives, a recognized minority, are the predominant residents of the NSB, the area that would likely be most affected by activities in the planning area under the four alternatives and activities associated with other projects on the North Slope. Environmental justice effects on Iñupiat Natives have occurred in the past from non-oil and gas, and from oil and gas impacts on their subsistence resources and harvest practices, as well as through impacts to human health (see **section 4.7.7.19 , *Human Health*** for a detailed description of cumulative impacts to the health of local residents). Causes of cumulative effects would include offshore oil and gas activity, commercial harvest of fish, oil spills, noise and traffic disturbance, and disturbance from construction activities associated with exploration and development on the North Slope. In addition, habitat reduction and increased local population pressure continue to challenge the survival of many traditional subsistence practices. It is expected that cumulative effects to subsistence resources, harvest practices, and sociocultural patterns from noise, disturbance, and oil spills would primarily impact the Iñupiat communities of Anaktuvuk Pass, Atqasuk, Barrow, and Nuiqsut within the NSB. The following sections discuss some of these impacts to Iñupiat Natives that have occurred in the past and could occur in the future. Since cumulative effects to subsistence resources have been discussed in much detail in earlier sections, the reader is encouraged to read earlier cumulative effects sections on vegetation, fish, birds, mammals, endangered and threatened species, subsistence and human health (**sections 4.7.7.5, 4.7.7.7, 4.7.7.8, 4.7.7.9, 4.7.7.10, and 4.7.7.12, and 4.7.7.19**).

4.7.7.14.1 Past and Present Effects and Their Accumulation

Prior to sustained contact between the Iñupiat of the North Slope and Euroamericans, effects to the sociocultural and subsistence activities of Native communities were primarily the result of natural factors, including weather and natural population cycles of subsistence animals. As discussed in **section 4.7.7.12, *Subsistence***, the advent of commercial whaling in the Pacific Ocean and subsequent Euroamerican influence had a profound affect on the people and resources of the North Slope. Effects on the Iñupiat of the North Slope included disease; introduction of new foodstuffs, including flour, sugar, coffee, and tea; the increased availability of alcohol and tobacco; ongoing efforts at acculturation of the Iñupiat through missions and government schools; and efforts to centralize and make sedentary the highly mobile populations of Iñupiat. The failure of commercial whaling by 1910 coincided with a depletion in the number of whales available for harvest, making the ongoing subsistence harvest difficult for the Iñupiat remaining along the Arctic coast. Further complicating subsistence whale harvest was a decrease in the Iñupiat population due to disease, accidents, and poor health care. Iñupiat and whale populations gradually recovered during the 20th century. Some whale populations, however, including bowhead whales, are still depressed from historic levels. Following a reduced presence of Euroamericans in the beginning of the 20th century, due to the collapse of commercial whaling, the Iñupiat returned to their highly dispersed way of life, with additional emphasis on fur trapping and reindeer herding as a source of money to buy those Euroamerican goods they desired. See also discussions on health-related changes during this period in **section 4.7.7.19, *Public Health***.

Oil and gas exploration from 1920 to 1968 brought changes to the Iñupiat people. By 1950, the Bureau of Indian Affairs was requiring families with school age children to relocate to population centers (e.g., Barrow) so that the children could attend school. Construction of a hospital and churches at Barrow also encouraged North Slope residents to settle there. Children were sent outside to boarding schools, including Chemawa in Oregon and Mt. Edgecumbe in Sitka. The children that returned from these boarding schools often became spokespeople for the community and interposed themselves between the forces of development and the conservation of traditional ways of life.

During the mid-20th century, the Department of Defense contracted for the construction of DEW-line and WACS sites on the North Slope. North Slope residents were no longer allowed to hunt near these locations, all of which were situated at or near important subsistence or residence sites. Operation of these sites by the military, and later by contractors, resulted in contamination of the surrounding area with fuel, oil, antifreeze, and other chemicals, which led to avoidance of these areas by subsistence harvesters concerned about chemical contamination. Postwar oil exploration and the sustained contact with Euroamericans, brought by activities associated with oil and the Cold War, resulted in additive impacts on subsistence resources, harvest patterns, and users. In addition, development associated with villages on the North Slope impacted subsistence resources. These activities cumulatively resulted in the loss of approximately 2,500 acres of habitat for subsistence species.

The most intense oil and gas development activity, and increased impacts to subsistence activities, occurred during the 1970s and early 1980s (e.g., development of the Prudhoe Bay and Kuparuk oil fields, construction of TAPS and the haul road, and construction of a large portion of the roads, drilling pads, gravel sources, collector pipelines, and production facilities). This activity has resulted in the cumulative direct loss and indirect loss of approximately 13,000 acres and 21,000 acres of habitat, respectively, for subsistence species, and higher levels of disturbance that can impact species health, reproduction, and survivorship.

As discussed in **section 4.7.7.12, *Subsistence***, North Slope residents have noted the decline of fish populations caused by seismic activities, the diversion of caribou from traditional migration routes and calving areas caused by an increased number of low flying aircraft, the disruption of caribou movements by low pipelines, and the ending of use of traditional harvest areas due to the avoidance of industrial areas by hunters. Oil and gas development in the Prudhoe Bay and Kuparuk areas discouraged Nuiqsut residents from using the eastern portions of their traditional harvest areas (Maps 3-36 and 3-37). Additionally, bowhead whaling quotas instituted by the International Whaling Commission resulted in the establishment of the Alaska Eskimo Whaling Commission. Some residents were profoundly concerned about impacts to marine resources, and so opposed any oil development in the marine environment.

Impacts to subsistence cased by the seismic exploration programs on the North Slope have also been observed for many years. Although seismic testing no longer uses dynamite on fish bearing lakes, Iñupiat blamed this activity for declines in fish numbers in the vast number of interconnected lakes and streams used by subsistence fishermen. Arnold Brower, Jr. stated in scoping testimony for the 1998 Northeast National Petroleum Reserve – Alaska meetings a consensus opinion among Iñupiat subsistence hunters that seismic testing, even in its current refined form, deflects subsistence animals from the areas it operates in.

In the past, oil and gas activities have deterred subsistence users from using their traditional subsistence use areas. The continued expansion of this activity across the ACP from Prudhoe Bay westward could increase the area considered off-limits by resource users, deflect or divert

important subsistence resources from their normal routes, and require users to travel farther to harvest subsistence foods (IAI 1990a). The continued increase in developed area would reduce the amount of suitable lands available for Nuiqsut residents to harvest necessary subsistence resources away from oil and gas facilities.

Summary of Past and Present Effects and Their Accumulation
Euroamerican presence, commercial whaling, and non-oil and gas development and oil and gas exploration and development have had cumulative impacts to Iñupiat culture and to fish and wildlife used for subsistence. Euroamerican presence has impacted the Iñupiat through disease and other ills. Commercial whaling nearly decimated whale stocks in the Chukchi and Beaufort seas; bowhead whale populations, though recovering, remain nearly 80% below levels in the 1800s. Non-oil and gas development associated with military, residential, and commercial development have directly impacted several thousand acres of fish and wildlife habitat and have also indirectly affected habitat and animal behavior effects that have accumulated and persist today. Oil and gas exploration and development conducted by the Federal government and industry have directly impacted the habitat use and behavior of subsistence species that also persists today. These effects have disrupted subsistence livelihoods, and may, in part, account for some of the social problems seen in the villages today.

4.7.7.14.2 Future Effects and Their Accumulation

The Iñupiat people, a recognized minority population and the primary subsistence users on the North Slope, will be affected by future disturbances to key subsistence species that leads to disruption, displacement, or long-term changes in species' populations. Expanded oil and gas development on the North Slope, on both Federal and state leases, would increase disturbance effects to subsistence species and harvest patterns. While each individual project would likely be a small incremental increase, the cumulative effect would eventually become more and more repressive to the subsistence lifestyle. Approximately 13,400 acres may be directly impacted by being covered with gravel or mined for gravel from oil and gas development associated with activities in the NPR-A and elsewhere on the North Slope in the future. Indirect impacts to soil, water, and vegetation could be three to four times the amount of direct disturbance.

In addition to direct and indirect loss of habitat that can affect subsistence species, noise and other disturbance associated with oil and gas development would divert, deflect, and disturb subsistence species, potentially having population-level effects that would accumulate. Oil and gas development could also affect subsistence harvest by causing subsistence hunters to avoid certain areas because of concerns about firearm safety, and perhaps for aesthetic reasons. Although the North Slope still has huge amount of area that is relatively undisturbed, the general subsistence-hunting environment continues to change in response to increased development. During the past several decades, populations of caribou, bowhead whales, and other wildlife and fish have generally increased, to the benefit of subsistence hunters, despite habitat, disturbance, and other effects that have accumulated. However, there is no certainty that these trends would continue into the future, especially as the effects of global climate change on the Arctic environment become more pronounced.

North Slope Iñupiat have repeatedly spoken out against planned and ongoing offshore oil and gas exploration development, due to the importance of bowhead whaling and sea mammal hunting to their cultural identity and well-being. Should offshore activity result in changes in the migration paths of whales, and an associated decrease in the ability for whalers to harvest them, this activity would have a substantial negative effect on this recognized minority population.

Oil-spill contamination of subsistence foods is another important concern regarding potential effects on Native health. Although some contamination remains on the North Slope from past military and government activities, and from the early days of oil and gas development, the effects on subsistence species and users are minor. Efforts to clean up old disposal sites in the past have helped to reduce the effects that would accumulate with spill effects in the future. Human health could be threatened in areas affected by oil spills, but these risks can be reduced through timely warnings about spills, forecasts about which areas may be affected, and even evacuation of people and avoidance of marine and terrestrial foods that might be affected. In the unlikely event that a large spill were to occur and contaminate essential whaling areas, major effects to subsistence resources could result from the combined factors of shoreline contamination, tainting concerns, clean-up disturbance, and disruption of subsistence practices. Such impacts would have a disproportionately high affect on Alaska Natives. Contamination of subsistence foods by oil spills would potentially affect Native health (see **section 4.7.7.19, *Human Health***), and health and survivorship of subsistence species.

Transportation facilities and activities would also contribute to cumulative effects to subsistence resources and, consequently, to the Native population. A new permanent road connection from TAPS to Nuiqsut and the NPR-A would also facilitate petroleum development, and could provide an additional travel route for the public to the North Slope. This could encourage more hunters and other visitors to travel to the planning area, increasing the potential for conflicts between subsistence users and other users of fish and wildlife resources.

It is acknowledged that cumulative sociocultural impacts have occurred on the North Slope and that Iñupiat culture has undergone a noticeable change. The influx of money from wage employment has added many benefits and raised the standard of living, but has also given rise to an array of social pathologies, including increased alcoholism, as discussed in **sections 4.7.7.13, *Sociocultural Systems* and 4.7.7.19, *Human Health***.

4.7.7.14.3 Global Climate Change

It is difficult to determine exactly how global climate change figures into the cumulative mix. It is expected that global climate change affects animal populations, but the type, location, and magnitude of effects appears to be the subject of some disagreement. Regardless of exactly what those effects would be, changes to the numbers of animals or patterns of animal behavior would affect subsistence harvests, and the effects would thus be interactive with those of other North Slope activities. Whether global climate change would exacerbate effects on subsistence species or ameliorate them remains a subject for speculation.

4.7.7.14.4 Contribution of Supplemental Alternatives to Cumulative Effects

This cumulative analysis assumes that currently planned development (e.g. Alpine Satellites) and winter exploration in the planning area would continue. Seismic exploration would occur in winter and would include the drilling of exploratory and delineation wells in areas not excluded by buffers. Exploration and development could originate from Inigok, Point Lonely, and the Umiat vicinity, and could encompass important subsistence harvest areas for moose, fish, caribou, and furbearers, affecting subsistence users in Nuiqsut and to a lesser extent in Atqasuk, Barrow, Wainwright and Anaktuvuk Pass. If permanent development is pursued in areas newly opened to exploration and leasing under alternatives B, C, and D, Iñupiat users are likely to avoid the area from 5 miles to 25 miles around those facilities for subsistence uses (Pedersen et al. 2000; Pedersen and Taalak 2001).

Allowing leasing and development of all or portions of the area north and east of Teshekpuk Lake under Alternatives B, C, and D would dramatically reduce the amount of undisturbed habitat to caribou, waterfowl, fish, and other subsistence species. Additionally, in opening this part of the planning area to leasing, infrastructure such as pipelines and CPFs developed in this area would make oil and gas production in the adjacent northeast portion of Northwest NPR-A and Beaufort Sea more likely in the foreseeable future. These effects to subsistence species would be greatest under Alternative C. Teshekpuk Lake would be deferred from leasing under the Alternative D, protecting waterfowl and other subsistence species that use the lake. In addition, RSO restrictions on permanent facilities in caribou habitat protection areas and the Goose Molting Area would limit the amount of surface disturbance that could occur north and east of Teshekpuk Lake; these restrictions would reduce the likelihood of cumulative effects to cultural resources. Under Alternative A, 600,000 acres associated with areas near Teshekpuk Lake would be closed to leasing.

4.7.7.14.5 Conclusion

Alaska Iñupiat Natives, a recognized minority, are the predominant residents of the NSB, the area that would likely be affected by exploration and development in the planning area and other past, present, and reasonably foreseeable projects on the North Slope. Environmental justice effects on Iñupiat Natives could occur because of their reliance on subsistence foods, and cumulative effects would increase the effects on subsistence resources and harvest practices.

Potential effects would focus on the Iñupiat communities of Anaktuvuk Pass, Wainwright, Barrow, Atqasuk, and Nuiqsut within the NSB. Based on potential cumulative, long-term displacement and/or functional loss of CAH, TLH, and WAH caribou habitat over the life of the Northeast NPR-A oil and gas lease sales, and from other oil and gas developments on the North Slope, this important subsistence resource could become less readily available or undesirable for use, or experience long-term population and productivity effects. Such impacts would disproportionately affect Alaska Natives. Access to subsistence-hunting areas and subsistence resources, and the use of subsistence resources, could change if oil development were to reduce the availability of resources or alter their distribution patterns.

Because the potential impacts of climate change on marine and terrestrial ecosystems in the Arctic would cause impacts on subsistence resources, traditional culture, and community infrastructure, subsistence-based indigenous communities in the Arctic would be expected to experience disproportionate, environmental and health effects.

In the unlikely event that a large spill were to occur and contaminate essential whaling areas, major effects to subsistence resources could result from the combined factors of shoreline contamination, tainting concerns, clean-up disturbance, and disruption of subsistence practices. Such impacts would have a disproportionately high affect on Alaska Natives. Contamination of subsistence foods by oil spills would potentially affect Native health, as would many other factors (see **section 4.7.7.19**).

4.7.7.15 Coastal Zone Management

Activities associated with cumulative effects on the North Slope include those occurring in the planning area under the supplement alternatives, oil and gas development in the Northwest NPR-A, Federal and state offshore oil and gas development, state and Native onshore oil and gas development, and oil and gas transportation. The activities associated with exploration, facility construction, operation and maintenance, and oil spills are the most important elements for the cumulative analysis because of their potential disturbance and habitat impacts.

The planning area is within the NSB. The NSB applies its Comprehensive Plan policies and CMP policies to all developments occurring on private, Federal, and state lands. Oil and gas development activities could include portions of road/pipeline corridors, including the offshore portions (such as inlets and bays) within the NSB boundary. Development activities occurring adjacent to the Colville and Ikpikpuk rivers that could affect coastal resources or uses, including activities described in exploration plans and development and production plans, could be subject to the statewide standards and NSB district policies of the ACMP. Policies of the ACMP are examined herein for potential conflicts with effects from oil and gas exploration or development activities. Potential effects are summarized as succinctly as possible. Additional information is contained in the Coastal Zone Management section of the 1998 Northeast IAP/EIS (USDOI BLM and MMS 1998).

While the planning area is excluded from the coastal zone because Federal lands are not considered part of the coastal zone, Federal and federally-permitted activities are subject to review for consistency with the Alaska Coastal Management Program (ACMP) Statewide Standards in 11 AAC 112 and the enforceable policies of the NSB Coastal Management Program (CMP). The coastal area subject to review of license and permit activities includes 25-mile strip of land along the coast and a one-mile area west of the Colville River. The coastal areas are indicated on the Coastal Zone Boundaries of Alaska maps. The NSB maps can be viewed at http://alaskacoast.state.ak.us/District/swf/nwNSB.htm. Therefore, onshore activities within the planning area and some offshore activities identified under the alternatives should be assessed against the ACMP, and the enforceable policies of the NSB CMP.

4.7.7.15.1 Past and Present Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Non-oil and gas activities on the North Slope are subject to all applicable stipulations approved in the 1998 Northeast NPR-A ROD, as well as any other Federal, state, or NSB regulations that pertain to the activities in question (for the planning area and remainder of North Slope). These activities include aircraft use for point-to-point transport, and wildlife and other aerial surveys; ground activities such as seismic surveys, resource inventories for paleontological and cultural excavations, research and recreational camps, and overland moves; and guided hunting and river float parties on the Colville River from the headwaters to areas below Umiat. Hazardous and solid waste spills, and removal and remediation have occurred at abandoned drill sites. Oil spills have occurred at fuel storage sites and camps, but the size of these spills have been small. Clean-up activities have not greatly disturbed subsistence harvest activities or the surrounding environment. Development associated with past military and other government activities, and from growth of villages, has had effects on subsistence species and subsistence users that were minor, but still persist today.

Oil and Gas Exploration and Development Activities

Coastal Development (11 AAC 112.200 and 11 AAC 112.220). Water dependency is a prime criterion for development along the shoreline of coastal waters. The intent of this policy is to ensure that onshore developments and activities that could be placed inland would not displace activities that depend on shoreline locations, which include marine, lakeshore, and river waterfronts.

Natural Hazard Areas (11 AAC 112.210). This statewide standard permits coastal districts and state agencies to identify and designate areas which natural hazards are known to exist that my present a threat to life and property. Development in these areas would be prohibited until siting, design, and construction measures for minimizing property damage and protecting against the loss of life were provided.

Flooding, earthquakes, active faults, tsunamis, landslides, volcanoes, storm surges, ice formations, snow avalanches, erosion, permafrost, and beach processes in the planning area should be considered. Onshore development would be sited in areas of permafrost. Development in these areas would be required to maintain the natural permafrost insulation quality of existing soils and vegetation.

Coastal Access (11 AAC 112.210). This standard requires that activities maintain or increase public access to coastal waters. Access to coastal areas by Iñupiat Natives has been restricted at Prudhoe Bay and other coastal facilities for safety concerns and for protection of oil field infrastructure. A concern brought up during scoping for the amendment was the inability of some Natives to visit historic cabins and campsites used by ancestors at Prudhoe Bay. The loss of access to some coastal areas on the North Slope is an effect that persists today.

Energy Facilities (11 AAC 112.230). The ACMP requires that decisions on the siting and approval of energy-related facilities be based, to the extent practicable, on 16 criteria within the energy facilities standard. The criteria within this standard require that facilities be consolidated and sited in areas of least biological productivity, diversity, and vulnerability and where effluents and spills can be controlled or contained (11 AAC 112.230 (a) [3] and [14]). The NSB CMP also requires that transportation facilities and utilities must be consolidated to the maximum extent possible (NSB CMP 2.4.5.2[f] and NSBMC 19.70.050.K.6).

In the past, facilities have generally been sited where oil resources were most easily accessed. As a result, areas with high biological productivity, especially coastal wetlands, have been impacted by oil and gas development. The loss of this productivity persists today. Recent technology, including innovations that reduce the size of the gravel footprint needed for development and production, and advances in directional drilling, have allowed oil and gas developers to site facilities in areas with lower biological productivity.

Utility Routes and Facilities (11 AAC 112.240) and Transportation Routes and Facilities (11 AAC 112.280). These statewide standards require that routes for transportation and utilities be compatible with district programs and sited inland from shorelines and beaches. Utility routes and facilities along the coast must avoid, minimize, or mitigate alterations in drainage patterns, disruption in wildlife transit, and blockage of existing or traditional access.

As discussed for bird and mammal resources, roads and pipelines have altered drainage patterns, disrupted wildlife movements, habitat use, and reproductive success, especially for caribou, and have restricted traditional access into important subsistence areas (NRC 2003).

Over 9,000 acres have been directly impacted by gravel roads and pads, and alteration in drainage patterns has occurred on nearly twice that many acres. Caribou avoid, or are hesitant to cross roads, during migrations to foraging and insect-relief habitats (see **section 4.7.7.9, *Mammals***).

Sand and Gravel Extraction (11 AAC 112.260). Extraction of sand and gravel is a major concern on the North Slope. Gravel resources are needed for construction of pads, roadbeds, berms, causeways, and docks to protect the tundra. The ACMP statewide standards indicate sand and gravel may be extracted from coastal waters, intertidal areas, barrier islands, and spits if no practicable noncoastal alternative is available to meet the public need.

Through 2001, over 6,300 acres had been impacted for gravel mines on the North Slope; prior to 1968, only 24 acres had been impacted (NRC 2003). Eighty percent of these mines were located in rivers, the remainder in tundra. As discussed in **section 4.7.7.7, *Fish Resources***, only about 1,800 acres of gravel mine disturbance persists today, evenly divided between tundra and river sites. Many of the river sites were filled in when the river channel shifted, while others have been reclaimed to provide deepwater habitat, which is important to wintering fish. Thus, most of the effects associated with past gravel mines have been compensated for through development of new fish habitat.

Subsistence (11 AAC 112.270). The statewide standard for subsistence indicates a project within a designated subsistence use area must avoid or minimize impacts to subsistence uses of coastal resources. Subsistence uses of coastal resources and maintenance of the subsistence way of life are primary concerns of the residents of the NSB. However, access to subsistence resources, and subsistence hunting and resource use have been affected by oil and gas development, as discussed in **section 4.7.7.12, *Subsistence***. Subsistence resource availability has been effected by direct and indirect loss of habitat and from disturbance to animals from pipelines, structures, support-bases, pump stations, and roads.

Policy 2.4.3(d) (NSBMC 19.70.050.D) requires that development not preclude reasonable access to a subsistence resource. Onshore pipelines and construction activities could cause disruptions to subsistence caribou harvests from access and movement conflicts. Iñupiat Natives tend to avoid hunting and fishing near oil facilities, and as discussed in Appendix J, they travel further to reach subsistence resources than occurred in the past.

Habitats (11 AAC 112.300). The ACMP statewide standard for habitats in the coastal zone requires that habitats be managed to avoid, minimize, or mitigate significant adverse impacts to habitat resources. This policy is supported by an NSB CMP policy requiring that development be located, designed, and maintained in a manner that prevents substantial impacts on fish and wildlife and their habitats, including water circulation and drainage patterns and coastal processes (NSB CMP 2.4.5.2[b] and NSBMC 19.70.050.K.2).

Past activities in the planning area and on the North Slope have degraded habitat, as discussed under related plant and animal resource areas. In the context of the North Slope and ACMP, the amount of habitat directly or indirectly harmed from oil and gas activities has been less than 1%, and most populations of fish and wildlife appear healthy and are stable or increasing. Caribou and bowhead whale, important subsistence species, have shown steady population gains during the past several decades (NRC 2003). Populations of brant and several species of shorebirds, however, are declining, although it is not known if the causes of the decline are related to activities on the North Slope, or from activities occurring on the migration or wintering grounds, or both. Some effects of oil and gas development have countervailing effects.

For example, vegetation and soil are lost from gravel mines, but mines also provide important wintering habitat for fish and loafing habitat for birds.

Air, Land, and Water Quality (11 AAC 112.310). The air, land, and water quality standard of the ACMP incorporates, by reference, all the statutes pertaining to, and regulations and procedures of, the ADEC. The NSB reiterates this standard in its district policies and emphasizes the need to comply with specific water and air quality regulations in several additional policies. Water quality can be affected by oil spills, accidental discharges of pollutants, deliberate discharges and emissions, and gravel operations.

As discussed in **section, 4.7.7.1 *Air Quality***, air quality on the North Slope meets NAAQS and air quality is relatively pristine. Arctic haze has occurred in the past, but the source of this haze appears to be pollutants from Europe and Asia (and to a lesser extent, northern Alaska). There have been minor effects to vegetation from air pollutants, but these effects are not likely to occur and persist at a level that would harm subsistence species.

Based on the history of military activities and oil and gas exploration and development on the North Slope, as discussed in **section 3.2.10, *Hazardous Materials***, large amounts of hazardous material and waste have been dumped on the tundra, often onto the ground or into unlined storage facilities, and these materials have impacted local surface and groundwater sources. Much of this material was removed in the 1970s and early 1980s, and some cleanup continues today, although some effects from these actions likely persist today.

Historic, Prehistoric, and Archeological Resources (11 AAC 112.320). The ACMP statewide standard requires that coastal districts and appropriate state agencies identify areas of the coast that are important to the study, understanding, or illustration of national, state, or local history or prehistory, including natural processes. The NSB developed additional policies to ensure protection of its heritage. Traditional activities at cultural or historic sites also are protected under the NSB CMP 2.4.3(f) (NSBMC 19.70.050.F) and 2.4.5.2(h) (NSBMC 19.70.050.K.8).

As discussed in **section 4.7.7.11, *Cultural Resources***, interest in the geology and archaeology of the North Slope began in earnest at the beginning of the 20th century, but access was generally limited to coastal or easily accessible areas (see **section 3.4.1.8, *European/Euro-American Expansion, Exploration, and Ethnographic Research***). Effects to cultural resources in the NPR-A have been occurring since 1923, when oil and gas exploration and mapping began with USGS surveys of the Reserve, assisted by Native guides. With the onset of the Cold War, military activity on the North Slope also affected cultural resources. During the 1950s, ground-disturbing activities associated with the rapid construction of the DEW-Line and WACS sites affected cultural resources. Continued and increasing amounts of oil and gas exploration and drilling across the North Slope further affected cultural resources and Native peoples' relationships with their ancestral homelands.

Following Alaska statehood in 1959, land selections were made by the state and Federal governments, which did not include Native land ownership except as provided for under the Indian Allotment Act of 1906. No effort was made at that time to inventory, identify, record, or document Native land use or historic and archaeological sites as a result of these land selections. As a result of this lack of strong legal protection, oil development and production during this initial period severely impacted cultural resources and diminished some peoples' relationships with their individual and collective history.

The most intense oil and gas development activity occurred during the 1970s and early 1980s (e.g., development of the Prudhoe Bay and Kuparuk oil fields, construction of TAPS and the haul road, and construction of a large portion of the roads, drilling pads, gravel sources, collector pipelines, and production facilities). These developments occurred following the passage of the NHPA (1966) and NEPA (1969) that mandated the identification of cultural resources potentially affected by these developments and mitigation of the impacts. In addition, these developments resulted in the discovery of many previously undocumented cultural resources. In part, increased oil and gas exploration and development activity prompted the NSB to initiate the Traditional Land Use Inventory. In 1977 and 1978, an archaeological survey was conducted in select areas of the NPR-A. This survey resulted in the identification of 728 cultural resource sites in the planning area.

Summary of Past and Present Effects and Their Accumulation

As most non-oil and gas development, and oil and gas development on the North Slope has occurred near the coastline, conflicts with the NSB and State of Alaska coastal zone management standards have occurred in the past. Specific issues include limits on access to coastal areas by Alaska Natives, disturbance to and deflection of caribou moving to insect-relief areas along the coast, loss of habitat, and loss of historical, cultural, and archaeological resources resulting from exploration and development along the coastline. Through consultation, conflicts between coastal zone management standards and proposed development that could occur in coastal areas have been reduced since implementation of coastal management standards.

4.7.7.15.2 Future Effects and Their Accumulation

The ACMP statewide standards and NSB enforceable policies that are relevant to the analysis of the alternatives for this supplement remain relevant for the cumulative case. Although the level of effects could increase for the cumulative case, the scenarios assumed for the analyses in this supplement would not be expected to conflict with the statewide standards or the district policies. Activities that would occur outside the boundaries of the NPR-A, but within the NSB (including the coastal zone), would require permitting and approval from the NSB before proceeding. Those activities would not be approved by the NSB if they conflicted with the coastal management program enforceable policies. In addition, BLM would consult with the State of Alaska DNR regarding coastal zone consistency determination when a lease sale is proposed to ensure that BLM is in compliance with the CZMA. Thus, effects would accumulate under coastal zone management in the future, but would not conflict with policies of the State of Alaska and Borough coastal zone management programs.

Coastal Development and Access (11 AAC 112.200 and 11 AAC 112.220)

The potential for Alaska Natives to be denied access to coastal areas would increase as more development occurs near the coast. However, BLM proposes to implement Lease Stipulation K-6 (Coastal Areas) to prohibit or minimize development within ¾ of a mile of the coastline. This lease stipulation should ensure that the coastline remains relatively unspoiled and allows for Alaska Native access to coastal areas adjacent to the NPR-A.

Energy Facilities (11 AAC 112.230), Utility Routes and Facilities (11 AAC 112.240), Transportation Routes and Facilities (11 AAC 112.280)

The NSB CMP contains several additional policies related to transportation and utilities that may be relevant to this analysis. All but one of the policies are best-effort policies and subject to some flexibility if: 1) there is a substantial public need for the proposed use and activity; 2) all feasible and prudent alternatives have been rigorously explored and objectively evaluated; and 3) all feasible and prudent steps have been taken to avoid the effects the policy was intended to prevent. Transportation development, including pipelines, which obstructs wildlife migration is subject to the three conditions listed above (NSB CMP 2.4.5.1 [g] and NSBMC 19. 70.050.J.3.f). The oil and gas industry, in consultation with Federal, state, and local agencies, has implemented policies and management procedures to minimize impacts to caribou and other wildlife from pipelines and other linear facilities that would benefit wildlife in the future. These include the requirement that pipelines and other utility lines use a common corridor.

Sand and Gravel Extraction (11 AAC 112.260)

The ACMP statewide standards indicate sand and gravel may be extracted from coastal waters, intertidal areas, barrier islands, and spits if no practicable noncoastal alternative is available to meet the public need.

Approximately 6,300 acres have been impacted by gravel mines on the North Slope (NRC 2003). Much of the gravel was obtained from gravel deposits within floodplains. But concerns arising from this practice prompted the USFWS to study the effects of floodplain gravel mining on the floodplains physical and biotic processes (Woodward-Clyde Consultants 1980). The study identified numerous examples of habitat modification, including increased channel braiding, loss of wintering areas, spreading of flow, and restriction of fish movements, such as fish mortality caused by stranding. The study also set forth guidelines for gravel mining to minimize floodplain damage (Joyce et al. 1980). In response to agency concerns, and the results of the USFWS study, new gravel mines have primarily been sited in upland sites since the 1980s. Few good sources of gravel have been identified in the planning area, although limited effort has been spent on identifying potential gravel sources within the Reserve. Future gravel sites would be sited in upland areas, and away from the coast, where feasible.

Subsistence (11 AAC 112.270)

Access to subsistence-hunting areas and subsistence resources, and the use of subsistence resources, could change if development were to reduce the availability of these resources or alter their distribution patterns. Activities that could affect subsistence resources and access include noise and traffic disturbance, disturbance from construction activities associated with ice roads, production facilities, pipelines, gravel mining, supply efforts, and a large oil spill and associated clean-up efforts. Of these, a large spill is the only occurrence that could substantially interfere with access to subsistence resources. If a large spill were to occur in an environmentally sensitive area and essential harvesting areas were contaminated, effects could result from the combined factors of shoreline contamination, tainting concerns, clean-up disturbance, and disruption of subsistence practices.

The other impacting factors either would not be expected to have more than local, short-term impacts, or could be effectively addressed through the proposed suite of lease stipulations and ROPs. The proposed lease stipulations and ROPs, existing regulations and management practices, and future conditions placed on permits for future projects would serve to assure that

the timing and monitoring of potential sources of disturbance would minimize conflicts with subsistence activities. Activities addressed for cumulative effects would not result in conflict with this statewide standard or with the district enforceable policies.

Habitats (11 AAC 112.300)

The effects of pipelines, roads, and facilities installation and construction are magnified when examining the wide array of potential development in the cumulative analysis. However, the analyses indicate that the potential additive effects would not substantially alter or interfere with the habitats, species, and activities that these standards address. Cumulative effects are not anticipated to increase the potential for conflict with these statewide standards. Siting of energy facilities, transportation, and utilities outside the boundaries of the NPR-A (but within the boundaries of the NSB and the coastal zone) would require NSB permitting and approval. The NSB policies would be addressed through this approval process, and permitting would be dependent upon adherence to these policies.

Air, Land, and Water Quality (11 AAC 112.310)

As discussed in **section 4.7.7.1, *Air Quality***, air quality on the North Slope meets applicable standards and air quality is generally good. Arctic haze has occurred in the past, but the source of this haze appears to be pollutants from Europe and Asia (and to a lesser extent, northern Alaska). As oil production declines on the North Slope, and new air pollutant control technologies are implemented, the amount of air pollutants would continue to decrease from historic levels on the North Slope.

Historic, Prehistoric, and Archeological Resources (11 AAC 112.320)

Historic, prehistoric, and archaeological resources are nonrenewable, and displacement or contamination of these resources could affect the cultural and scientific values of the resource. The cumulative effects of oil and gas exploration and development within the planning area and across the North Slope are difficult to estimate given the scattered nature of historic, prehistoric, and archaeological resource deposits, their surface or near-surface contexts, and difficulty in predicting their location. As long as surveys and inventories were completed prior to exploration and development, the effects on these resources would be minimized. The accidental discovery or damage to sites, presently known or unknown, would to some extent damage those sites, but would also require measures to recover or record the remaining material, adding that information to the archaeological record of the North Slope.

The NHPA requires agencies, or their permittees, to complete a cultural resources survey before any undertaking occurs (i.e., a ground-disturbing activity, such as well drilling, construction of infrastructure or the construction of buried pipelines) on Federal lands. BLM's guidelines and policies require that all effects to any cultural resources identified during surveys must be mitigated to the satisfaction of the land manager and the SHPO. Lease stipulations and ROPs developed for the action alternatives would minimize or prohibit exploration and development activities near major rivers, reducing the likelihood of impacts to historic, prehistoric, and archaeological resources.

4.7.7.15.3 Global Climate Change

Rising temperatures are altering the Arctic coastline and changes are projected to continue during this century as a result of reduced sea ice, thawing permafrost, and sea-level rise (ACIA

2004). Thinner, less extensive sea ice creates more open water, allowing stronger wave generation by winds and increasing wave-induced erosion along Arctic shores.

Rising sea level is very likely to inundate marshes and coastal plains, accelerate beach erosion, and force salt water into bays, rivers, and groundwater. Coastal regions with underlying permafrost are especially vulnerable to erosion as ice beneath the seabed and shoreline thaws from contact with warmer air and water. The projected increase in air and water temperature, reduction in sea ice, and increase in height and frequency of storm surges are expected to have a destabilizing effect on coastal permafrost, resulting in increased erosion.

A 2003 study by the General Accounting Office found that 184 out of 213 Alaska Native villages are affected by flooding and erosion to some extent and that the increased susceptibility to flooding and erosion is due in part to rising temperatures. In the Alaskan village of Nelson Lagoon, residents have built increasingly strong break walls along the shore, only to see them destroyed by increasingly violent coastal storms. The village of Shishmaref, located on an island just off the coast of northwest Alaska and inhabited for 4,000 years, is now facing the prospect of evacuation resulting from erosion. The coastline along the North Slope is receding approximately 8 feet a year, more rapidly than coastlines in other parts of the world. As this process continues, loss of cultural and paleontological, soil, vegetation, and habitat resources would accumulate and would be irreversible within our lifetimes.

4.7.7.15.4 Contribution of Supplement Alternatives to Cumulative Effects

Most of the coastal area, from Atigaru Point to the boundary with the Northwest NPR-A, would be closed to leasing under Alternative A. Lease Stipulation K-6, Coastal Areas, under Alternatives B through D requires that permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines established to support exploration and development activities shall be located at least ¾ mile inland from the coastline to the extent practicable. Where, as a result of technological limitations, economics, logistics, or other factors, a facility must be located within ¾ mile inland of the coastline, the practicality of locating the facility at previously occupied sites such as Camp Lonely, various Husky/USGS drill sites, and Distant Early Warning (DEW)-Line sites, shall be considered. Use of existing sites within ¾ mile of the coastline shall also be acceptable under this stipulation of Alternatives B through D where it is demonstrated that use of such sites will reduce impacts to shorelines or otherwise be environmentally preferable. All lessees/permittees involved in activities in the immediate area must coordinate use of these new or existing sites with all other prospective users. Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission, the Nuiqsut Whaling Association, and the NSB to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope. Adherence to this lease stipulation should ensure that coastal resources are adequately protected. All Federal activities and federally-permitted activities affecting coastal resources and uses must be reviewed for consistency with the ACMP. Therefore, onshore activities within the planning area and some offshore activities identified under the alternatives should be assessed against the ACMP, including the enforceable policies of the NSB CMP.

Alternatives B, C, and D would open the northwest portion of the planning area to leasing. Infrastructure such as pipelines and CPFs developed in this area would make oil and gas production in the adjacent Beaufort Sea and northeast portion of Northwest NPR-A more likely in the foreseeable future. Synergistic impacts associated with Beaufort Sea development could be considerable in or near the coastal zone in that a pipeline traversing the northern section of the planning area may provide the only means to transport offshore oil and gas to TAPS and a

gas pipeline. Consequently, development would be accelerated or become more likely under these action alternatives compared to Alternative A.

4.7.7.15.5 Conclusion

Effects on access to subsistence hunting and subsistence resources would offer the greatest opportunity for conflict with the statewide standards and the NSB policies related to these concerns. Increase in noise and disturbance from cumulative oil development would be additive and could have localized, short-term effects on some subsistence resources and access to some resources. Noise and disruption could be effectively addressed through lease stipulations and ROPs, existing regulations and management practices, coordination, and future permitting processes including Federal, state, and local processes as applicable. Federal regulations require and implement strict oil spill prevention standards, and a large spill would be considered unlikely. In addition, the lease stipulations and ROPs would effectively address prevention and response relative to small and large spills. Conflicts with statewide standards of the ACMP and the policies of the NSB are not inherent in the scenarios assumed for this supplement.

4.7.7.16 Recreational Resources

In addition to the direct and indirect impacts described under the alternatives analyses, cumulative effects to recreational resources on the North Slope would result from past, present and future activities and facilities that affect solitude, naturalness, or primitive/unconfined recreation. Short-term or transient loss of the area's naturalness and solitude from such impacts as pads/trails and noise from aircraft and equipment would not be cumulative. Therefore, their contribution to the cumulative impacts would be "momentary." In contrast, long-term development, such as roads and production pads, would accumulate in their impacts to the area's naturalness and solitude.

4.7.7.16.1 Past and Present Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Temporary structures (e.g., sleds, tents), vehicles (e.g., Rolligons, tractors), noise from generators, aircraft, human presence, and associated activity would have had short-term impacts on the experience of solitude, naturalness, or primitive/unconfined recreation. Because all of these identified non-oil and gas activities would have been transitory and short term, the likelihood of recreationists encountering them in any given location in the 57 million acre North Slope or in the 4.6 million acre planning area is probably small, unless recreation activities were centered around villages or oil and gas facilities, or occurred along major rivers and coastal areas, where human presence is more prevalent.

A longer-lasting impact would have been from trails resulting from overland moves. These are trails that were created by vehicles compacting snow and dead vegetative matter that in turn results in the greater availability of moisture and nutrients for underlying vegetation the following growing season. These trails do not necessarily develop over the entire route of an overland move, but when they do they can be very detectable from the air for 2 to 5 years. They usually are difficult to recognize from the ground. Another impact along these trails that has occurred in the past is vegetation being damaged or broken or the tops of tussocks being scraped off. Though still relatively short term in nature, the linear nature of these trails emphasize the

presence of man, which would have reduced the sense of naturalness and unconfined primitiveness to a small degree.

Oil and Gas Exploration and Development Activities

Seismic work has occurred over much of the ACP. This work resulted in a short-term impact on the primitive setting of the North Slope and a loss of solitude and naturalness. These impacts would have been confined primarily to the activity site viewshed or noiseshed, or approximately ½ mile in any direction. The potential effects on recreation opportunities and experience were minimized by the fact that very little winter recreation takes place in the area.

A longer-lasting impact occurred from green trails resulting from seismic survey operations. As with green trails created by overland moves, these trails do not necessarily develop over the entire survey route and are visible for about 2 to 5 years. Though relatively short term in nature, the linear nature of these trails would have emphasized the presence of man, which would have reduced the sense of naturalness and unconfined primitiveness to a small degree.

Other sources of potential recreation loss included exploration sites with gravel pads, disturbed areas around these pads, exploration airstrips, and gravel exploration roads. Based on a report by the NRC (2003), in 2001, approximately 1,200 acres had been impacted by these sites on the North Slope in the past, and 740 acres of disturbed areas were still evident. Most of these sites were developed before 1977, thus, their effects on the vegetative landscape have persisted for decades, and are likely to persist for several more decades.

Disturbances associated with exploration, development, and production activities continue to have a potential affect on the recreational experience. Temporary on-site location of structures (e.g., drilling rigs); noise from generators, vehicles, aircraft, etc.; human presence; and associated activity all would have short-term impacts on solitude, naturalness, and primitive/unconfined recreation experiences during the winter season. Through 2001, over 500 acres of peat roads still showed evidence of disturbance, even though most of these roads were constructed over 50 years ago (personal conversation w/ Mike Kunz). Gravel footprints had impacted over 9,200 acres, while gravel mines had impacted another 6,360 acres of vegetation. Of this, all but 70 acres of gravel footprint persisted in 2001, but over 4,500 acres of gravel mines were reclaimed. Motorized traffic occurs along about 400 miles of roads (NRC 2003). These impacts to the recreation experience are greatest within a 2-mile radius of the facility, and for permanent, and some temporary, facilities, these effects persist today.

Wilderness Values

Past activities on the North Slope, particularly those associated with oil and gas development east of the Colville River, have reduced the naturalness of a portion of the planning area and reduced the area affording opportunities for solitude, personal challenge and unusual adventure, and primitive and unconfined recreation. In addition, effects on wildlife have degraded the wilderness experience potential to some degree.

Wild and Scenic River Values

During preparation of the Northwest IAP/EIS, 22 streams and rivers including the Colville River, were found eligible for inclusion in the National Wild and Scenic Rivers System (USDOI BLM MMS 2003:V-165). However, no rivers were found suitable for inclusion.

4.7.7.16.2 Future Effects and Their Accumulation

Under Alternative D, it is expected that long-term impacts to recreation experiences over an area of approximately, 650,580 acres would occur. Considering past, present, and future development across the North Slope, total cumulative impacts would be additive and could affect an area three to five times greater. If commercial gas development occurs on the North Slope, construction activities, most of which would occur in winter, would have little impact on recreation, which is rare at that time. Evidence of construction, i.e., disturbance to and changes in vegetation along a linear route would affect the recreation experience for several years. Longer term impacts of gas development would be limited to those associated with gas-only field development, any above-ground gas pipelines (not considered the preferred method of transport), possible prolongation of activities associated with some oil and gas fields, and compressor stations along the route of buried gas pipelines. Even so, a vast area of the ACP, and certainly more than 80% of the North Slope and planning area, would remain relatively untouched. However, the types of development anticipated would not be uniformly distributed across the planning area or the North Slope, nor would recreational or wilderness values be perceived as uniformly dispersed. Cumulative impacts along popular rivers, such as the Colville River, would be seen as far more important than impacts elsewhere.

Wilderness Values

The cumulative development scenario for all alternatives would reduce the naturalness of a portion of the North Slope where non-oil and gas, and oil and gas development may occur, and would reduce the area affording opportunities for solitude, personal challenge and unusual adventure, and primitive and unconfined recreation. In addition, effects on wildlife would degrade the wilderness experience potential to some degree. Nevertheless, most Federal lands on the North Slope would remain roadless and would retain the characteristics necessary for future considerations. If oil and gas development occurred close to currently designated wilderness areas, such as portions of ANWR or Gates of the Arctic National Park, some of the wilderness values associated with those designated wilderness areas would be reduced. Transportation of oil, which predominantly occurs in above-ground pipelines, would have a greater impact to the sense of naturalness than would transportation of gas, because gas pipelines would probably be buried, surfacing only occasionally to pass through a compressor station.

Wild and Scenic Rivers

The Colville River and 22 other rivers in the National Petroleum Reserve have been identified as eligible for designation. The Colville River within the Northeast and Northwest NPR-A planning areas has not been found "suitable" because BLM manages only the left bank (facing downstream) above the highest high water mark, and neither the local population nor the State of Alaska support designation at this time. The right bank is controlled by the State of Alaska and the Arctic Slope Regional Corporation. These entities could authorize modifications such as airstrips, lodges, cabin sites, or storage facilities in the riparian area that would impact the scenic quality and the free-flowing, clean water nature of the river. Such modifications would make it very difficult to maintain the nondegradation standard of management if the Colville River adjacent to the planning area were found suitable for designation as a Wild River Area. Most of the eligible rivers, which are found in the Northwest planning area of the NPR-A are in remote areas and would likely not be affected by development, or would be protected by lease stipulations and ROPs.

Effects of Spills

Most spills (65 to 80%) would be confined to a pad. Spills not confined to a pad usually are confined to the area immediately around the pad or pipeline. Therefore, impacts on solitude, naturalness, or primitive/unconfined recreation opportunities resulting from spills likely would be confined to the same area as described above.

A large oil spill that reaches a river, especially the Colville River, and moves rapidly downstream could have disastrous short-term (and possibly long-term) impacts on recreation values.

4.7.7.16.3 Global Climate Change

As discussed in earlier sections on Water Resources, Vegetation, Birds, Mammals, and Subsistence, global climate change could impact natural resources on the North Slope and have an effect on the recreation experience and types and timing of recreation activities that could occur. For instance, if global climate changes the location of birds or caribou it will have a direct effect on sport hunting and where hunters must go to find these animals. Climate change may very well displace some of the current recreation use and replace with other types i.e. more water based vs. current land based.

4.7.7.16.4 Contribution of Supplemental Alternatives to Cumulative Effects

Under Alternative D, it is expected that long-term impacts over an area of approximately 650,580 acres would occur. This would be about 12% more than the area affected under Alternative A, but about 14% less area than would be affected under Alternative C. Considering past, present, and future development across the North Slope, total cumulative impacts would be additive and could affect an area three to five times greater. Even so, a vast area of the ACP—and certainly more than 80% of the planning area—would remain relatively untouched and would retain the characteristics necessary for future Wilderness designation if political support for such a designation were to coalesce. However, the types of development anticipated would not be uniformly distributed across the planning area or the North Slope, nor would recreational or wilderness values be perceived as uniformly dispersed. Cumulative impacts along popular rivers, such as the Colville River, would be seen as far more important than impacts elsewhere.

4.7.7.16.5 Conclusion

Cumulative development activities would degrade the opportunities for primitive recreation in portions of the planning area and elsewhere on the North Slope. However, such opportunities would continue to be available over at least 80% of the planning area and substantial portions of the North Slope. Technically, there would not be cumulative impacts to Wilderness or Wild and Scenic Rivers in the planning area or much of the North Slope, because currently only portions of ANWR and Gates of The Arctic constitutes the only designated wilderness and the Ivishak River in ANWR constitutes the only Wild and Scenic River on the North Slope. However, the area eligible for future designation would be reduced to the degree that a major disturbance occurred. Projected cumulative activities could have local impacts on the free-flowing, unpolluted waters and could affect the outstandingly remarkable values of portions of the eligible Colville River. In such a case, the amount of area potentially suitable for designation would be reduced. If oil and gas development occurred close to an area of designated

Wilderness, such as portions of ANWR or Gates of the Arctic, impacts could occur to the wilderness values associated with those designated lands.

4.7.7.17 Visual Resources

Activities associated with non-oil and gas activities (primarily development associated with villages, military / DEW-Line sites, cabins and campsites, and airfields), as well as inland oil and gas exploration and development and Beaufort Sea oil and gas development have resulted in cumulative effects to visual resources on the North Slope. Impacts to visual resources have also resulted from on-the-ground management activities, such as archaeological collection efforts, field camps, survey work, overland movements, and hazardous and solid material removal and remediation activities.

4.7.7.17.1 Past and Present Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Most of the North Slope and planning area are still primarily a natural landscape where humans have not substantially changed the scenic quality. However, some areas have been modified by human activities. Buildings are the most likely developments to be seen and have the most modification from the natural landscape. The main areas where buildings exist in the planning area are Nuiqsut, Point Lonely and Umiat. Other areas outside the planning area but near by and possibly visible in the distance are, Cape Simpson and Lonely DEW-Line site. Other communities on the North Slope include Atqasuk, Anaktuvuk Pass, Barrow, Kaktovik, Point Lay and Wainwright. There are 13 former or current military sites on the North Slope in various stages of use and rehabilitation.

Landscape modifications associated with villages and developments, including single family houses, temporary structures, (e.g., sleds, tents), roads and trails, vehicles (e.g., Rolligons, tractors), commercial development, landfills, airstrips, and aircraft have impacts on visual resources or scenic quality, by creating a contrast to the form, line, color, and texture of a primarily horizontal natural landscape. The facilities introduce vertical blocky regular shapes and lines to an irregular horizontal landscape. The colors of structures and equipment contrast with the white color of the snow-covered landscape and the various hues of greens and browns, and the smooth texture of the facilities contrast with the varied textures of the windswept terrain and the irregular texture of vegetation. Non-oil and gas activities that occurred within the Foreground-Middleground Zone of the viewshed likely attract the attention of the casual observer. Some development in the Background Zone may also be seen due to the flatness of the landscape.

Other buildings found throughout the North Slope are cabins and camp structures associated with subsistence activities. These structures are usually isolated single-story small plywood cabins that produce some contrast with the surrounding landforms, but on a very local scale, along lakes, rivers, and creeks. One exception, however, is along the Miguakiak River and Teshekpuk Lake where structures are more clustered or appear as "strip development."

Very few roads or trails exist very far from any community. Summer travel is primarily by watercraft along rivers and coastal areas. Some areas around Nuiqsut receive travel by ATV, however, these trails are hard to see from more than about 25 feet away at ground level. A longer-lasting impact has been "green trails" resulting from winter overland moves between

villages. Trails form when vehicles compact snow and dead vegetative material, resulting in a greater availability of moisture and nutrients for underlying vegetation the following growing season. These trails did not necessarily develop over the entire route of the overland move. Vegetation has been damaged along these trails and the tops of tussocks have been scraped off. Trails are visible for about 2 to 5 years from ground level but are visible for longer periods if viewed from an elevated position. However, because they visually modified existing vegetation, rather than adding something foreign into the viewshed, trails have not produced much contrast to line, form, or texture. The color contrast would be minimal from ground view because of the natural variation in hue, and would be almost nonexistent from more than a few hundred feet away.

Airstrips are located at five remote places within the planning area; airstrips are also located at villages, oil and gas fields, and Deadhorse. While the profile of an airstrip is low, landform changes are introduced by brown colors in predominantly green vegetation and more regular lines than the surrounding irregular vegetation.

While these areas introduce modifications to the landform, they also provide places of use and special interest or key observation areas from which to evaluate the sensitivity levels.

Oil and Gas Exploration and Development Activities

Past exploration activities have resulted in over 20,000 miles of seismic surveys, most of which would not be visible to the casual person after five years from the survey date if viewed from ground level, however, trails remain visible for much longer periods of time if viewed from an elevated position.

A longer-lasting impact has been trails resulting from winter overland equipment moves. Commonly known as "green trails," they form when vehicles compact snow and dead vegetative material, resulting in a greater availability of moisture and nutrients for underlying vegetation the following growing season. These trails did not necessarily develop over the entire route of the overland move. Vegetation has been damaged along these trails and the tops of tussocks have been scraped off. Many trails are visible for about two to five years; however some trails have persisted for over 20 years (NRC 2003). However, because they visually modified existing vegetation, rather than adding something foreign into the viewshed, trails have not produced much contrast to line, form, or texture as viewed from the ground. The color contrast would be minimal if viewed from the ground level because of the natural variation in hue, and would be almost nonexistent from more than a few hundred feet away. However, if viewed from an elevated position, trails are visible with changes to color, line and texture.

Past development and production of oil and gas on the North Slope has cumulatively impacted about 35,000 acres from surface disturbance associated with roads, pads, and exploration sites; about 12,000 acres of surface impacts are still visible today (NRC 2003). In addition, about 400 miles of pipelines have been constructed at one time or another. Visual impacts from oil and gas facilities and activities have changed the existing landscape from a very natural viewshed to a more industrialized setting introducing vertical lines, regular patterns, and varied colors. From some viewpoints, it is possible that multiple developments could be seen in the Foreground-Middleground Zone, as well as the Background Zone and Seldom-Seen Zones of the same viewshed. These visual effects persist today, and unless sites are dismantled and rehabilitated, would accumulate with future effects. Less than 1% of facilities constructed with gravel fill areas have been rehabilitated by 2003 (NRC 2003). Because natural recovery in the Arctic is slow, the visual effects caused by oil and gas exploration and development activities are likely to

persist for centuries (NRC 2003). Many of the facilities from past production are still present and have not been rehabilitated.

An unknown number of capped wells (called Christmas trees) dot the landscape. However, given the small footprint and most being less than six feet tall, these modifications are very hard to see unless you are within a couple hundred feet of them.

Drill rigs (average height of 208 feet) have introduced strong vertical lines into a predominantly horizontal landscape. Because they are painted red, most drill rigs also produce a strong visual contrast to the white background of the snow-covered landscape. Winter drilling requires lighting, which creates a visual contrast against the dark night sky.

Permanent roads are primarily associated with the TAPS and the oil fields road network. As of 2001, there were approximately 400 miles of oil field roads, about 75% of which were constructed by the early 1980s. These roads can be visible from a mile or more away. Ice roads are used during the winter months and leave changes in vegetative colors during the summer, but again, this contrast is very hard to see from more than a few feet away. Peat roads constructed during early exploration activities, on the other hand, destroyed the overlying tundra and created a driving surface on the underlying frozen ground or used the overlying tundra as road material creating an elevated driving surface. This disturbance to the color and texture of the landscape may be visible from most of the Foreground-Middleground Zone, especially from an elevated position and are still visible 30 to 50 years later.

4.7.7.17.2 Future Effects and Their Accumulation

Activities Not Associated With Oil and Gas Exploration and Development

Cumulatively, the non-oil and gas activities that would occur on the Arctic North Slope would be similar to those described under past and present effects. However, trails and temporary camps would increase as a result of, or in support of, oil and gas development. For example, field activities associated with archeological site clearances (such as camps, excavations, and aircraft activity) would all likely increase.

Although the amount of supplies and materials transported by winter overland moves would increase with additional activity on the North Slope, these moves would generally follow the same routes. New trails could be developed to reach new staging areas and pump stations; however, once a route was identified, numerous trips over the route could occur with little additional impacts.

Oil and Gas Exploration and Development Activities

Cumulatively, seismic-survey work would continue each winter season. These operations could result in hundreds of miles of intermittent trails. As production of fields increases, seismic work would tend to decrease and trails would reduce in number and recover naturally. Exploration activities in the foothills area of the North Slope may result in visible trails for longer periods of time due to the topography which increases the likelihood of vegetation damage (NRC 2003). These impacts to visual characteristics would be seen in texture, line and color more than form.

Some exploration wells would leave behind a marker pipe expected to be no larger than a square foot on the surface and 6 feet tall. This impact would essentially be permanent, although it would be almost unnoticeable from several hundred feet away.

In addition to the impacts that have resulted from ongoing exploratory drilling operations, the greening of vegetation under vacated ice pads, ice airstrips, and ice roads has caused impacts to visual resources during the summer. This greening of vegetation is caused by the same conditions that create "green trails," a greater availability of moisture and nutrients as ice or compacted snow melts. There has also been a "ring effect" around ice pads, ice airstrips, and ice roads caused by the death of vegetation adjacent to these snow and ice structures. The effects of ice roads and pads are short-term, however, and would not accumulate. Where ice pads are left over summer with insulated pads to prevent thawing, it is reasonable to expect some damage to vegetation that is visible for up to 3 to 5 years, or longer, depending on the vegetative type.

Present development and production could impact less than 1% of the North Slope, while reasonably foreseeable future development could impact around 1% of the North Slope area. However, remediation of old drill sites is ongoing, and many of the impacts have a natural recovery rate of less than 15 to 20 years. The ring effect from old well sites would also naturally recover in less than 15 to 20.

Visual impacts from oil and gas development activities would continue to become more noticeable as production pads, staging areas, CPFs, gravel roads, gravel mine sites, airstrips, and pipelines change the landscape. In many areas, the increase in development and production would change the existing landscape from a very natural viewshed to a more industrialized setting introducing vertical lines, regular patterns, and varied colors. From some viewpoints, it is possible that multiple developments could be seen in the Foreground-Middleground Zone, as well as the Background Zone and Seldom-Seen Zones of the same viewshed. If production around communities occurs, such as has happened near Nuiqsut, the viewshed from these villages would be substantially altered in line, form, color and texture by the construction of facilities. Smog, haze and fugitive dust produced from facilities would impact the viewing quality of the area. Burnoff flares from production rigs and lighting would make these structures visible at night and during the winter dark periods. Many of the facilities associated with oil and gas production will persist well into the future and accumulate as new facilities are brought online and old facilities remain in usable condition with rehabilitation efforts deferred. It is projected that approximately 18,300 acres or 0.03% of the North Slope would be disturbed by gravel pads, roads, gravel material sites and other infrastructure by 2010 (Table 4.7-H).

Off-shore developments as viewed from on-shore will have impacts to line, form, color and texture by introducing vertical, predominately smooth, blocky – geometric buildings and facilities that are painted various colors into a predominately flat or irregular, smooth or jumbled, horizontal, blue-grey landscape.

Effects of Abandonment and Rehabilitation

During abandonment and rehabilitation activities, vehicle traffic on roads would create short-term noticeable visual impacts through the creation of dust. Once closure activities are completed, the strong contrasts of line, color texture and form between structures, such as pipelines and buildings would be eliminated; however, gravel pads, roads and airstrips would likely remain and be reshaped and reseeded with native vegetation or matted with biodegradable materials to allow for natural reseeding. These facilities would accumulate over time and be visible if viewed within the Foreground-Middleground Zone.

Effects of Spills

Most small spills would be confined to a pad. Spills not confined to a pad would usually be confined to the limited area immediately around the pad or pipeline. Large oil spills occurring during the summer could impact up to 62,000 acres. If vegetation is destroyed by the spill material or clean-up process, recovery would take years and be accumulative with changes to line, texture and especially color to the natural landscape.

4.7.7.17.3 Global Climate Change

Changes in global climate may influence coastal erosion rates, amount of surface water, stability of the soil, and amounts and types of vegetation on the North Slope. All of these effects would have an impact on the visual characteristics of line, form, color and texture of the North Slope and planning area; however, these changes would be subtle over time and appear as a natural process.

4.7.7.17.4 Contribution of Supplement Alternatives to Cumulative Effects

The number and length of seismic surveys in the planning area would be the same under all alternatives. There would be about 250 miles of 2-D surveys and 10,560 miles of 3-D surveys for each alternative. Seismic work would occur in the winter using cat trains with low-ground-pressure vehicles supported by light aircraft. Seismic crews would be housed in mobile camps consisting of a train of trailer sleds pulled by tractors and would add another 840 miles of trails. These moving camps and associated activities would result in short-term impacts on visual resources and the scenic quality of the area by creating a color contrast between the vehicles and trailers and the predominantly white background of the snow-covered landscape. These impacts would be confined primarily to the activity-site viewshed and the Foreground-Middleground Zone.

Trails (approximately 11,650 miles and 108,000 acres) resulting from seismic survey operations would result in a longer-lasting impact to visual resources and would be similar among alternatives. Unlike overland moves, seismic operations would not follow the same routes every year, and the number of miles of survey line could vary greatly from year to year. In some years, no surveys would occur. Like trails caused by overland moves, trails caused by seismic operations would not necessarily develop over the entire survey route, but where present would be visible for about 2 to 5 years. Because trails visually modify existing vegetation, they would not produce much contrast to line, form, or texture. The color contrast would be minimal from ground view because of the natural variation in hue, and would be almost nonexistent from more than a few hundred feet away and visible only in the Foreground-Middleground Zone.

Approximately 151, 170, 210, or 193 exploration and delineation wells would be drilled under alternatives A through D, respectively. It is estimated that the long-term disturbance associated with the new wells would be about 6 acres per well. Given the limited number of drilling rigs available, however, no more than eight drilling rigs would likely be operating at any one time. Assuming approximately 6 acres for each ice pad, 11 acres for airstrips, and 3 acres per mile of roads per drill site, as many as 16,768 acres under Alternative A, 20,022 for Alternative B, 23,463 under Alternative C and 20,202 for Alternative D would be in various states of recovery from greening and ring effects under the alternatives.

It is estimated that long-term surface disturbance from gravel production pads, infield roads, airstrips, gravel pits, and infield gathering pipelines would impact 2,818 acres under

Alternative A, 3,664 for Alternative B, 4,649 under Alternative C and 4,538 for Alternative D. Pad sites generally contain one-story buildings and pipelines. The gravel pads would generally be only 3 to 5 feet above the surrounding green tundra, and would be relatively unnoticeable beyond a few thousand feet.

It is estimated that long-term surface disturbance from staging bases, pump stations and CPFs would impact approximately 650 acres under Alternative A, 810 for Alternative B, 970 under Alternative C and 810 for Alternative D. Facilities would introduce strong vertical lines from buildings into the landscape of predominately horizontal lines. There would also be a visual contrast between the simple, regular form of the buildings and the complex, irregular forms of the vegetation. Colors of buildings and materials would contrast with the greens, and browns, of vegetation and blues of water bodies. Some of the buildings could be up to three stories in height above the tundra, and would attract and dominate the view of the casual observer if located within the Foreground-Middleground Zone.

It is anticipated that as many as 491 acres under Alternatives A, B and D and 551 under Alternative C would be disturbed for sale oil and main pipelines (approx. 3 acres per mile). There would be no on-the-ground activities associated with pipelines, except during construction, inspection, and repair. Pipelines would introduce shiny and smooth horizontal lines into the naturally irregular brown and green landscape. They would also introduce regularly spaced vertical supports into an irregular horizontal landscape. Pipelines would be elevated at least 5 feet above the surrounding tundra under Alternative A and 7 feet under the other alternatives, but could be elevated as high as 20 feet above ground level (personal observation 2003). At these elevations, the pipeline would attract the attention of the casual observer if located within the Foreground-Middleground Zone.

Considering past, present and future development across the North Slope, total cumulative impacts would be additive. Development in areas of interest such as travel routes along rivers or the coast or areas where people congregate such as camps and cabin areas, or communities would have the most impacts to visual resources and facilities would probably be visible in all three zones (Foreground-Middleground, Background and Seldom seen Zones). Alternatives B, C, and D would be more likely to have development along travel routes or visually sensitive areas than Alternative A and enhance the possibility of development in adjacent areas outside the planning area. Even so, a vast area of the North Slope would remain relatively untouched (acres affected under Alternative A would impact only 0.44% of the North Slope area, Alternative B 0.45%, Alternative C 0.46%, and Alternative D 0.45%). However, the types of development anticipated would not be uniformly distributed across the planning area or the North Slope, nor would scenic values or changes to landscape characteristics be perceived the same from all locations. Cumulative impacts along popular travel routes and from key observation areas such as native communities and gathering places, would be seen as far more important than impacts elsewhere.

In addition to the different contribution to the cumulative impacts from the direct and indirect impacts of the four planning area alternatives, the alternatives could differently affect the visual resources of the northeastern part of Northwest NPR-A and the Beaufort Sea north of the Teshekpuk Lake area. Under Alternative A, oil and gas infrastructure is not allowed in the area north of Teshekpuk Lake. This could reduce the potential for, or slow, oil and gas development in northeastern Northwest NPR-A and in the Beaufort Sea, compared to the other alternatives that make lands north of Teshekpuk Lake available for leasing and development. Consequently, Alternatives B, C, and D could result in greater impacts to visual resources in Northwest NPR-A and the Beaufort Sea than Alternative A.

4.7.7.17.5 Conclusion

There would be a small increase in the short-term impacts to visual resources from non-oil and gas activities. Short-term impacts, such as trails, and ongoing activities would not accumulate. Impacts from long-term or permanent facilities such as gravel roads, pipelines, and gravel pads and material sites would accumulate and would result in the long-term loss of scenic quality. Pipelines could be elevated above ground level and would be visible from the Foreground-Middleground Zone. Except during construction, inspection, and repair of pipelines, there would be no associated on-the-ground activity.

Long-term impacts from production sites, staging areas, pumping stations and CPFs with a possible life span of over 30 years would affect visual resources in the North Slope. It is expected, however, that these impacts would be greatest within the Foreground-Middleground Zone of the viewer. Some of these facilities may be visible from the Background Zone and Seldom Seen Zone in areas of low elevational change or if viewed from an elevated position.

4.7.7.18 Economy

Introduction

This section addresses the cumulative effects of past, present, and future activities on the economy of the North Slope and the state of Alaska. Three primary indicators are used to assess cumulative effects on the economy. These three indicators are NSB revenues, jobs, and per capita income. The reader is advised to refer to **section 4.7.7.12, *Subsistence*** for the primary discussion of cumulative effects on subsistence. Key events or factors are described, followed by an analysis of these events, and a discussion of the trends that have affected the economy and are expected to continue into the future.

4.7.7.18.1 Past and Present Effects and Their Accumulation

Key Events/Factors
Historically, commercial whalers entered the Chukchi and Beaufort seas in the 1850s, pursuing whales for oil and baleen. Whaling captains hired North Slope Natives as crew members and eventually these Natives became captains of their own ships.

In the 1890s, the Bureau of Education introduced reindeer into the region, providing additional food for the herders and cash for meat sold to whalers and others. By 1915, the over harvest of bowhead whales and the development of substitutes for baleen and whale oil led to the end of commercial whaling.

By the time commercial whaling ended, the cash economy was well integrated into the North Slope economy and new sources of income were needed to compensate for the loss of whaling income. Trapping became an important source of income for the region until the Great Depression brought a substantial decline in demand for furs. In the mid- to late 1920s, the caribou populations crashed and the bands of Iñupiat living in the Brooks Range dispersed to other areas, not returning to the mountains until the late 1940 and 1950s.

World War II began the development of airports around the state, and North Slope residents were involved as Army Scouts. After World War II, the International Whaling Commission was established and the U.S. Navy built its Arctic Research Laboratory near Barrow. The Navy also

began its early petroleum exploration on the North Slope. Both of these activities provided steady employment in the region. As the Cold War evolved, and the threat of nuclear war emerged, the Department of Defense began to build the DEW-Line radar sites along the Alaska coastline from 1955 to 1957. This construction activity and operations provided some employment for local residents.

Alaska became a state in 1959, and by 1962 an MOU was signed to transfer Bureau of Indian Affairs schools to the state; however, many Bureau of Indian Affairs schools continued to exist in the state until the early 1980s.

As pointed out by the NRC (2003), the discovery of oil in 1968 at Prudhoe Bay "accelerated political processes for resolving complex issues of land tenure and rights…." The Alaska Native Claims Settlement Act (ANCSA) established the ASRC and the village corporations in 1971, and led to the formation of the NSB in 1972, as well as the resettlement of the villages of Nuiqsut in 1973 and Atqasuk in 1974.

The Dalton Highway opened in 1974 and the first oil flowed down the TAPS in 1977, providing a wealth of revenues to the State of Alaska and the NSB, with the first Permanent Fund Dividends paid to residents of the state in 1982. The ANILCA in 1980 established the network of national parks, refuges, wilderness areas, preserves, and other Federal land ownership that exists today on the North Slope.

Oil production at the Prudhoe Bay field peaked in 1988 and began to decline. Production from the Kuparuk field started in 1990, after there was sufficient capacity in the TAPS to accept more oil. The petroleum industry had limited exploration success after the early discoveries in the late 1960s and early 1970s, until the discovery of the Alpine field in 1995. Alpine, located near the eastern boundary of the NPR-A, represented a new geologic concept for oil reservoirs on the North Slope and provided further impetus for opening the Reserve to exploration to private companies.

Revenue

Property tax receipts by the NSB grew from almost nil in 1975 to a peak of about $250 million in the mid-1980s. These are currently just under $200 million (2005). State of Alaska general fund petroleum revenue was $25.4 million in 1959, 12% of total revenues. The proceeds are estimated at $4.3 billion for 2007, 88% of unrestricted general fund revenue. (ADR 2006) NSB revenue is presented in **section 3.1.1.1**; state revenue in **section 3.1.1.3**. Taxes are shown in Figure 3-1 in Chapter 3.

Aside from the petroleum industry, the NSB is the dominant economic organization on the North Slope. The NSB taxes the oil and gas facilities and uses the revenues to provide education and a wide array of other public services within its boundaries. Property taxes on oil and gas infrastructure provide over 95% of the total revenues received by the NSB. The value of the infrastructure is based on the estimated value of the profits that can be generated with these facilities. As the amount of oil reserves remaining in the ground declines over time, the value of the facilities also diminishes, followed by subsequent reduction in the property taxes generated. The NSB has uses its tax authority to issue bonds used for capital improvement projects and pledges future revenues to pay for these projects. The NSB must meet its debt service requirements on these bonds even if oil and gas property taxes decline, thus the result can be a substantial decline in operating budgets as tax revenues diminish.

Prudhoe Bay and Kuparuk were the largest and second-largest fields discovered in North America. Even though these fields are in decline, they still produce a significant portion of the oil on the North Slope.

Lease sales have been completed in Beaufort Sea (Beaufort 195, MMS 2005 and State of Alaska 2006), Northwest NPR-A (BLM 2006), and North Slope Foothills (State of Alaska, 2006, 2007).

Employment

As evidenced by Figure 3-2 in chapter 3, without the discovery of oil at Prudhoe Bay in 1968, the number of jobs that would be available for North Slope residents would be substantially fewer than presently exist. Although most oil and gas-related jobs are held by people who reside outside of the NSB, jobs funded by the NSB's property tax revenues account for the vast majority of the jobs outside of the oil and gas sector. The number of jobs in the oil and gas-related sectors has fluctuated with the development of new fields, and the development and end of construction of new, large fields (e.g., Kuparuk and Alpine) is evident. Current oil and gas extraction industry employment estimates prepared by the Alaska Department of Labor and Workforce Development indicate employment has grew from 5,500 jobs in January 2006 to 6,900 jobs in January 2007 (ADOLWD 2007).

Per Capita Personal Income

As shown in figure 3-5 in chapter 3, real (inflation adjusted) per capita personal income in the NSB has declined from peak years in the 1970s and early 1980s, with over $40,000 in income, to under $30,000 in income in the latter part of the 1990s. In comparison, per capita personal income for the state remained between $25,000 and $30,000 from the 1970s through the early 1980s, and has remained relatively stable from the early 1980s through the end of the last decade. In 2004, per capita income in the NSB was $39,350, while statewide it was $33,761.

Subsistence

Iñupiat tend to begin their time allocations with wage labor decisions and then divide the remaining time between subsistence and leisure. North Slope residents tend to allocate relatively less time to subsistence as they increase their employment time. This effect in what has become a mixed cash/ subsistence economy is discussed in detail in **sections 4.7.7.12 and 4.7.7.13**.

Summary of Past and Present Effects and Their Accumulation

The NSB has transformed to a mixed cash-subsistence economy. Particularly in the last 40 years, residents have both benefited and grown accustomed to the result of modern capital development on the North Slope. In addition to the petroleum industry, the NSB has become a dominant economic organization on the North Slope. The NSB taxes the oil and gas facilities and uses the revenues to provide education and a wide array of other public services within its boundaries. Property taxes on oil and gas infrastructure provide over 95% of the total revenues received by the NSB.

4.7.7.18.2 Future Effects and Their Accumulation

Key Events/Factors

The BLM, MMS, and State of Alaska continue to hold lease sales for onshore and offshore oil and gas exploration in Alaska. However, the response of the oil and gas industry to these recent lease sales demonstrates the industry's recognition of the high cost and high risk of exploration in areas located far from current infrastructure. While some exploration activities are occurring far from current production areas, most exploration is located near existing infrastructure in order to reduce costs or exploration and achieve a higher probability of finding economically viable reserves.

The Alpine satellite fields are examples of this type of exploration activity. Colville Delta-3 (Fjord) was discovered approximately 6 miles north of Alpine, and CD-4 (Nanuq) was discovered about 4 miles south. Colville Delta-5 (Alpine West) is about 3 miles from CD-2, CD-6 (Lookout) is about 10 miles from CD-5, and CD- 7 (Spark) and CD-6 are separated by about 6 miles.

Fjord and Nunaq are located on lands owned by the State of Alaska and the Kuukpik Corporation, the Alaska Native village corporation for Nuiqsut. The subsurface rights to the oil and gas are held by the State of Alaska and ASRC. A similar situation exists for the Alpine field. Alpine West is proposed to be located within the NPR-A, on Kuukpik land and an ASRC oil and gas lease. The royalties to ASRC from production of these fields would generate substantial revenues for the corporation and its shareholders. Seventy percent of these petroleum royalties would be shared with the other Alaska Native regional corporations in accordance with Section 7(i) of ANCSA.

Reasonably foreseeable events that would affect the economy of the NSB and the state of Alaska include oil and gas exploration and development on existing leases on State and Native-owned lands east of NPR-A, Federal leases in NPR-A, and federal and state leases in the Beaufort Sea. Also, future oil and gas lease sales and oil and gas development in the NPR-A, Chukchi Sea, Beaufort Sea, and lands east of NPR-A, as well as construction of a gas pipeline to take North Slope gas to market may become important to the economy.

Revenue

Alaska Department of Revenue's current estimates indicate petroleum revenue dropping to just over $2 billion in 2016. Its proportion of general fund revenue will fall to 77% by 2016. (ADR 2006).

The current downward trend in declining oil and gas property taxes is expected to continue. Potential oil production from recent and future lease sales in the NPR-A could help to slow this decline, but is not expected to reverse the trend. If, however, a gas pipeline is constructed to bring North Slope gas to market, revenues could increase substantially and reverse the downward trend. The Final Environmental Impact Statement: Renewal of the Federal Grant for the Trans-Alaska Pipeline System Right-of-Way in 2002 estimated that revenues from the pipeline would amount to $189 million annually in royalties and severance taxes and $188 million annually in property taxes. (USDOI BLM, 2002) These figures should be used with caution, however, because the exact amount of revenues would depend on as-yet-to-be-determined tax rates, actual daily throughput, and market price of natural gas at the time of transmission. In addition, with a natural gas pipeline, it is likely that additional oil and gas

infrastructure would be built on the North Slope to produce gas for market and, thereby further increase property tax, and possibly, other revenues.

Employment

As oil fields mature they typically require more employees per unit of production, so even though profits and property taxes may decline, employment in the oil and gas sector may remain constant or even increase slightly. However, in the government sector and other sectors funded primarily by the State's revenues or NSB's property tax receipts, employment is expected to decline as tax receipts decline. Employment in the oil and gas sector could remain within the range of employment levels experienced between 1980 and 2003, while the number of jobs supported by the NSB's property tax revenues is expected to decline in concurrence with the reduction in tax receipts cited above. The State of Alaska must also develop alternate sources of funds for their staff and programs. Future lease sales on the North Slope could help to mitigate some of these employment losses, but are not expected to offset them unless there is construction of a commercial gas pipeline and future gas development on the North Slope.

Cumulative gains in direct employment would include added jobs in petroleum exploration, development, production, and possibly oil spill clean up activities. Indirect and induced employment would be generated as well. The cumulative effects are projected to generate added employment and personal income increases as follows:

- 232 jobs annual average for NSB residents during development, declining to 40 during These include direct oil industry employment, indirect and induced employment.
- $16.3 in total average annual personal income for workers residing in the NSB during development, declining to $3.7 million during production.
- 7,480 jobs on an annual average during development, declining to 3,750 during production. These jobs are for workers on the North Slope who reside in southcentral Alaska and Fairbanks. These include direct oil industry employment, indirect and induced employment.
- 60 to 190 jobs for 6 months for cleanup of unlikely oil spills in the Beaufort Sea.
- Additional workers commute to residences outside Alaska, as noted in Chapter 3. As much as 30% of the workforce in the oil industry is nonresident to Alaska.

This information was derived from Section IV.C.12 of the Northwest NPR-A IAP/EIS, Section V.C.11 of the Liberty Final EIS (USDOI, MMS, Alaska OCS Region, 2002b), and Section V.C.10 of the Beaufort Sea Sales 186, 195, 202 Final EIS (USDOI, MMS, Alaska OCS Region, 2003) (USDOI 2003). Actual employment is expected to fluctuate with actual levels of oil and gas activity, which can be impacted by long-term changes in the prices of oil and gas and by the construction of a gas pipeline and subsequent gas development.

Per capita income in the NSB is expected to increase near term, and then level off or decline slightly. Future changes in employment opportunities and migration of NSB residents would also affect this indicator. The longer-term trend in decreasing per capita income may continue unless NSB residents seek opportunities in the North Slope petroleum industry. The availability of employment opportunities in the planning area, with development and production of known and potential oil and gas fields, could increase employment opportunities for Nuiqsut residents who live in close proximity to these fields. While wages associated with this employment could raise the per capita income for Nuiqsut residents, it would likely represent a very small increment for the NSB. For the state of Alaska, changes in the planning area will have little effect on per capita income, which is expected to continue to grow.

4.7.7.18.3 Contribution of Supplement Alternatives to Cumulative Effects

Based upon our analysis assumptions, the combined 2021 property taxes to the NSB and State of Alaska from future oil and gas development in the planning area could range between $40 million (Alternative A) and $42 million (Alternative C). These numbers could be higher or lower depending on the future price of oil and the amount of infrastructure development. The property tax payment will increase as development proceeds adding satellites and additional fields. The estimated annual royalty and severance payments to the state could be $330 million in 2021. These revenues would not differ between alternatives for at least thirty-five years; in later years those alternatives that are projected to add the most development would maintain the revenue flows the longest. Royalties and taxes could add $500-$525 million for the Federal government in 2021.

It is anticipated that employment of NSB residents would increase in the range of 105-225 jobs during development and by smaller amounts during production. The annual employment of Alaska residents (excluding residents of the NSB) would increase in the range of 1,500 to 3,200 jobs during development (Alternative A), and 1,700-3,400 (Alternative C), with the numbers for the other alternatives falling in between these estimates. A total of as many as 3,300 to 7,200 direct, indirect, and induced jobs may be added as a result of Alternative A. Under Alternative B, this number would only be slightly higher. In either Alternative C or D, the number would be approximately 3,880-7,600 jobs added. Alternatives B, C, and D would open the northwest portion of the planning area to leasing. Infrastructure such as pipelines and CPFs developed in this area would make oil and gas development in the adjacent northeast portion of Northwest NPR-A and Beaufort Sea more likely in the foreseeable future, leading to more jobs being attributable to activities in those areas than otherwise would be the case.

The proximity of Nuiqsut to the planning area enhances the community's opportunities to benefit from development and production activities associated with all of the alternatives. These opportunities could extend to community businesses that might provide goods and services, as well as residents who might obtain work as a result of the development and production activities.

4.7.7.18.4 Conclusion

Subsistence activities (non-cash economy) and the oil and gas industry (cash economy) are the primary factors that affect the economic livelihood of the North Slope residents. The NSB has successfully leveraged tax revenues generated from oil and gas properties to improve the quality of life of its residents by providing basic services such as water, sewer, electricity, fire protection, police protection, education, health services, and by building infrastructure to support these services through capital improvement projects. Construction jobs associated with the NSB's capital improvement projects have provided residents with employment opportunities that pay relatively well and allow for flexibility to accommodate subsistence activities. Alaska has benefited statewide from revenues resulting from oil production.

As expected, property tax revenues have decreased through the years, as North Slope oil and gas production decline and facilities continue to depreciate. Correspondingly, historical employment data indicate a declining trend in the number of jobs in the North Slope. The declining trend in revenues, jobs, and per capita incomes are expected to continue into the future (absent a major economic event such as the natural gas pipeline project that would create a natural gas industry). It seems reasonable to envision a future trend with more North Slope residents participating in oil and gas activities as Borough-related employment opportunities

become very limited. This could mean a tradeoff in subsistence activities as jobs in the oil and gas industry would not be able to provide the same level of flexibility as the Borough and construction jobs.

Events in the reasonably foreseeable future, such as exploration and development in other areas of the NPR-A, could mitigate these declining trends, but are not expected to offset these declines unless a gas pipeline is built. The development associated with the Northeast NPR-A could also have implications at the national level. The Department of Energy estimated that the contribution of North Slope crude to domestically produced oil supplies would decline from 18% in 2004 to 14% in 2020; again, this decline could be mitigated, but not offset, by opening up the Northeast NPR-A to oil and gas exploration. Any increase in domestic oil production is expected to reduce U.S. dependency on foreign oil supplies, and, in turn, improve national energy security and the overall balance of trade.

4.7.7.19 Public Health

4.7.7.19.1 Past and Present Effects and Their Accumulation

Impacts to the health of the North Slope Inupiat people have occurred since the first direct interactions with people from outside the region. Beginning with Russian fur traders in the 1700s, the early contact era was characterized by the introduction of epidemic infectious diseases. Early measles and smallpox epidemics resulted in a substantial population decrease and persisted into the early 1900s. In the early 1900s, pandemics of influenza and tuberculosis resulted from contact with whalers and the concentration of population in larger and more sedentary centers. A pandemic of influenza in 1918 dramatically reduced the Inupiat population in some villages, particularly around Norton Sound. Epidemic infectious disease was eventually largely controlled through intensive public health interventions and improved living conditions and sanitation beginning in the 1950s (Institute of Social and Economic Research 2006).

Commercial whaling north of the Bering Strait began and ended in approximately 60 years. In addition to the associated infectious diseases, it resulted in the introduction of new foodstuffs (e.g., flour, sugar, coffee, and tea), the increased availability of alcohol and tobacco, ongoing efforts at acculturation of the Iñupiat through missions and government schools, and efforts to centralize and make sedentary the highly mobile Iñupiat populations. The changes initiated during this time formed the early basis of the changes in health status described in **section 3.4.10**, namely, a trend toward increases in chronic metabolic diseases, cancer, and social pathology, accompanied by general improvements in life expectancy and infant mortality.

The dietary, cultural, and health changes experienced since the 1950s are similar to general trends observed in circumpolar other Inuit communities. Studies have linked modernization and acculturation with increases in metabolic disorders such as diabetes, cardiovascular diseases, cancer, and social pathology such as domestic violence, alcohol and drug abuse, and suicide (Bjerregard 2001; Curtis, Kvernmo et al 2005; Krauss & Buffler 1979; Shepard and Rode, 1996). The extent to which oil and gas development may have contributed to these trends is incompletely understood, but well-documented causal pathways can be identified, and local testimony strongly suggests a causal connection between many of the changes in health status – both positive and adverse – and oil and gas development.

General health indicators – such as infant mortality and life expectancy – have improved over the last 40 years. Revenues from oil development support the NSB as the region's top employer, and income from Native Corporation dividends and employment (particularly in Nuiqsut) support a generally higher economic standard of living, employment opportunities, and public health and sanitation infrastructure, all of which are associated in the public health literature with improved population health status.

But despite these improvements in overall mortality figures, significant disparities remain in terms of overall health status, and cancer, social pathology, and chronic diseases are rapidly increasing. Life expectancy at birth for Alaska Natives remains significantly lower than for the general population (69 compared with 76 years). Since 1979, Alaska Native mortality rates remain roughly 1.3 times higher than the U.S. population, and on the North Slope, overall mortality rates are roughly 1.5 times higher than the U.S. population. Rates of assault, domestic violence, and unintentional and intentional (homicide and suicide) injury and death in the North Slope remain far higher than in the general U.S. population, despite the improvements in unintentional injuries delineated in Chapter 3.4.10 (Lanier et al. 2002; Day et al. 2006; Goldsmith et al 2004; U.S. Department of Health and Social Services 2006).

Public testimony on prior EISs in the region has indicated a persistent concern that regional industrialization may be at the root of some of these persistent health disparities. For example, testifying in 2001 on the MMS' Liberty DEIS, Rosemary Ahtuangaruak, a former health aide who received advanced training as a physician's assistant, stated:

> Increased incidents of community social ills associated with rapid technological and social change cause problems with truancy, vandalism, burglary, child abuse, domestic violence, alcohol and drug abuse, suicide, and primarily the loss of self-esteem. This has materialized during transient employment cycles. The influx of construction workers bring their own problems to a village impacted by oil development activities already. Historically, from past experience, we know that the incidents of alcohol and drug use increase dramatically (USDOI MMS 2001).

Similarly, previous North Slope Borough Mayor George Ahmaogak noted that:

> The benefits of oil development are clear — I don't deny that for a moment. The negative impacts are more subtle. They're also more widespread and more costly than most people realize. We know the human impacts of development are significant and long-term. So far, we've been left to deal with them on our own. They show up in our health statistics, alcohol treatment programs, emergency service needs, police responses –you name it (Ahmaogak 2004).

Some concerns regarding the contributing role of oil and gas development to social pathology appear well-founded in accepted mechanisms of health and illness, as well as public health data. For example, residents have expressed concern that increasing ice road access or eventual gravel road access to previously isolated communities, and the influx of oil workers from outside these communities, may lead to increases in drug and alcohol trafficking. Data has shown a strong correlation between effective prohibition, adequate law enforcement and better health outcomes in Alaska Native villages (Wood and Gruenewald 2006; MMS 2001); anything which would compromise the efficacy of local prohibition would thus exacerbate alcohol, drug, and social problems in the impacted community. Similarly, residents have noted the very direct link between oil and gas activities, impacts to subsistence, and the resultant stress and maladaptive coping mechanisms which have deepened social pathology in the villages. Data indicate a

strong link between the integrity of subsistence and sociocultural traditions and health (for example, Curtis, Kvernmo et al 2005; Wexler 2006). Thus, to the extent that oil and gas development at Prudhoe Bay, Kuparuk, and other fields east of the Colville River has created more difficult subsistence conditions and has eliminated previously culturally and practically important areas from use, social pathology may have been exacerbated. One study demonstrated a clear link between acculturation pressure and suicide in Inupiat communities, but made the point that this effect is mitigated to some extent by economic development (Travis 1984.) Thus, the economic benefits of oil development may to some extent offset the adverse social pathological impacts of development.

Injury rates reflect not only the challenges of subsistence life in the Arctic but also the contribution of social pathology, which lead to problems such as domestic violence and suicide, as well as alcohol and drug abuse which increase the risk of accidents as well as violent behavior. Injury rates on the North Slope have been decreasing over the last 40 years, but remain far higher than rates in the general population (ANTHC 2006; Day et al 2006). Much of the decrease in injury rates is attributed to aggressive public health intervention campaigns such as helmet education programs, and to effective prohibition laws and enforcement. Impacts of oil and gas development on social pathology would have predictable effects on injury rates. Also, as oil infrastructure has encroached on and displace subsistence resources, residents have had to travel farther at times for successful hunts. Longer travel times result in statistically increased chance of injury as well.

Dietary change may result not only from impacts to subsistence resources, but from increased availability of convenience foods in stores, increases in income, and alterations in the cultural preference for foods. Data indicate that the overall per capita subsistence harvest in the North Slope remains robust, and among the highest in Alaska, and that income related to past oil development may in part facilitate subsistence (ADF&G 2000; Kruse & Braund 2004, in press). But diabetes appears to be increasing rapidly in the Inupiat as discussed in **section 3.4.10**, owing to dietary change and a more sedentary lifestyle. Data shows that influences which lead to modernization of Arctic communities in general result in lower consumption of subsistence foods (Bjerregaard, Jorgensen et al 2004; Schraer and Bulkow, 1993). The transition toward a 'modern' diet is occurring to various extents throughout the state of Alaska, owing to socioeconomic changes which have occurred at the state level. The specific contribution, then, of oil and gas activities on the North Slope is not possible to quantify. However, because of both the displacement of subsistence resources and hunters, and the large-scale local economic changes produced by oil development, it is reasonable to infer that oil development is playing a role in local dietary change.

Residents have also expressed concern over the marked increase in pulmonary disorders such as asthma, certain types of cancer, and thyroid disease; many worry that these problems result from environmental contamination related to local industry. Data are not sufficient to analyze these concerns. Oil and gas development operations would emit air pollutants that are respiratory irritants, such as NOx, SOx, and fine particulate ($PM_{2.5}$). However, air quality monitoring in the North Slope has not included data on $PM_{2.5}$, one of the main environmental contributors to respiratory and cardiovascular illnesses. In addition, a detailed inventory has not been conducted for hazardous air pollutants (HAPs), a diverse group of contaminants associated with an array of human health effects including carcinogenesis, birth defects, learning disabilities, and endocrine disruption (AMAP 2003). Furthermore, as discussed in the Air Quality analysis, intercontinental transport of airborne pollutants renders the attribution of air quality impacts to local sources even more complex. Finally, monitoring and reporting requirements for HAP do not require measurement of the accumulation of HAP in ground,

vegetation, or animal populations. For these reasons, it is not possible to model the potential contribution of local industry to health problems with accuracy. However, smoking rates are high on the North Slope, and likely contribute to the prevalence of pulmonary disease and specific cancers such as lung cancer. And although incomplete, data on some subsistence foods in the region appear to demonstrate that the subsistence food supply in the North Slope region is relatively safe (O'Hara, Hoekstra et al 2005; Alaska Department of Public Health 2004a and 2004b; AMAP 2003). Nevertheless, given the preexisting health disparities and vulnerabilities in this population, and their extraordinarily high consumption of local subsistence resources, the potential contribution of contaminants is a serious concern. While studies linking the prevalence of specific health problems to locally-emitted contaminants would be limited by the small sample size, public health experts advocate stringent controls on exposure.

4.7.7.19.2 Future Effects and Their Accumulation

Continuing oil and gas leasing and development, potential community population growth, as well as on-going changes in the Arctic climate, will have impacts on Iñupiat public health in the foreseeable future. Development is currently proposed in the northeast corner of the planning area (Alpine Satellite Development), and further exploration and delineation activity is ongoing in the leased areas south of Teshekpuk Lake. If oil and gas development were to occur in areas already leased in NPR-A as well as on leased State and Native corporation lands to the north and east of Nuiqsut where development has already occurred, village residents would be increasingly isolated from their subsistence resources and would be encircled by development, as stated by elder Ruth Nukapigak (1982) and others in the community. If development is allowed to proceed to the north of Teshekpuk Lake, the establishment of pipelines to the region could stimulate more interest in development of northwest NPR-A as well as the OCS and near-offshore region north of NPR-A. Activity in this region would have impacts to subsistence activity for surrounding villages, particularly Barrow, Atquasuk, and Nuiqsut.

Offshore leasing has become more intense recently as well. The notice announcing a proposed Chukchi Sea lease sale (MMS OCS Sale 193) generated higher than expected interest from industry, leading MMS to prepare a full EIS for the sale; development has begun on the "Oooguruk" project, a near offshore island near the Colville Delta, prompting concerns in Nuiqsut over potential impacts to their subsistence fishery; and a deferral on leasing in Nuiqsut's whaling area near Cross Island was recently removed by the MMS, which could lead to impacts to whaling as well.

If a pipeline is built to take North Slope gas to market, public health impacts similar to those associated with past oil development can be anticipated. Gas pipeline and other gas facility construction and operation of gas infrastructure would emit air pollutants, with possible health implications, especially to any nearby populations, though possibly through contamination of food sources. Gas development could bring additional jobs and income to North Slope residents and revenues to the NSB. These have implications for changes in lifestyle with both positive and negative health impacts and a source for funding social services by the NSB, which can mitigate health impacts. Gas development is not likely to be as disruptive of caribou and subsistence hunter movement as oil development because most pipelines would be buried and many gas developments would use already existing oil infrastructure. However, the opportunity to develop gas could prompt more overall oil and gas development and related infrastructure (drilling pads, CPFs, aboveground infield pipelines, gravel roads, airstrips), including the possibility of some gas-only developments outside the planning area. This aboveground infrastructure could have impacts to subsistence resources and create other aboveground infrastructure that will further narrow the area of subsistence use.

The central question when considering the cumulative health effects of all foreseeable development is whether it will be possible for the North Slope Inupiat to maintain a culture and way of life based on subsistence. Residents fear that the combination of pressures they now face – modernization, acculturation, global warming, and curtailment of subsistence through expanding development – threatens the viability of this cornerstone of Inupiat life, and may ultimately change the fundamental character of their society. Destabilization of the cultural and social systems would be expected to produce serious health consequences. As oil and gas development both on and off shore expands in the region, more villages may face impacts similar to those now being experienced by Nuiqsut.

Cumulative Impacts Related to Specific Health Problems

1. Diabetes, Hypertension, and Associated Metabolic Disorders
Subsistence constitutes the most important protective factor against diabetes and related metabolic disorders (hyperlipidemia, metabolic syndrome); dietary change has also been linked to hypertension in Inuit groups. These disorders, along with smoking which is highly prevalent on the North Slope, constitute three of the most important risk factors for heart disease, strokes, and renal failure, which are among the most important causes of mortality and disability in the U.S. The prevalence of diabetes and metabolic disorders in Inuit communities has been shown to be proportional to the degree to which people have replaced subsistence intake with modern store-bought food. Consumption of subsistence foods has also been found to be higher amongst older Inuit (Shraer, Bulkow et al 1987; Jorgensen, Bjerregaard et al. 2002; Murphy, Schraer et al 1997; Nobmann, Ponce et al 2005).

In the face of the development presumed to occur for analysis of cumulative impacts (see **sections 4.7.2 and 4.7.3**), subsistence will face a number of concomitant challenges to its ongoing viability as a primary source of nutrition. The expansion of foreseeable oil and gas development on and offshore has the potential to displace hunters and subsistence resources from a much wider area than is presently occurring. Concomitantly, ongoing modernization and sociocultural effects of increased income, employment, and prolonged and potentially more intense contact with the 'dominant' US culture through increasing numbers of oil and gas workers in and near villages would also be expected to lead to a relative shift away from subsistence foods. Increasing regional population could increase competition for subsistence resources. Global warming may cause dramatic shifts in the presence, quality, and availability of subsistence resources as well, but the degree and direction of change is not certain. The degree to which these changes will occur, and the severity of impacts, will likely vary across the region. Nuiqsut, for example, has largely been excluded by development from the eastern portion of its subsistence range, and will be the first village to note changes as development proceeds to the west. The community will experience multiple overlapping threats to subsistence, whereas other villages farther removed from the planning area may experience fewer simultaneous challenges.

If subsistence were displaced from its primary role in the diet, public health professionals in Alaska worry that, particularly given the presence of other risk factors such as a likely genetic predisposition, low quality of available store-bought food in the villages, and high smoking rates, any action which might displace subsistence from its primary role in the diet could trigger an epidemic of diabetes, hypertension, obesity, and cardiovascular disease, such as has been observed in other tribes throughout the lower 48 states.

2. Food Insecurity and Hunger

Although malnutrition and starvation were common as sporadic occurrences in northern subsistence-based people historically, modern infrastructure, economy, and government support have rendered these problems exceedingly rare in the present day. However, food insecurity and hunger – antecedents of frank malnutrition and starvation – are prevalent in the U.S., and are considered to be severe health problems themselves, apart from these ultimate outcomes. Even in early stages, both food insecurity and hunger are associated with significant psychological dysfunction, learning problems, poor self-reported health status, poor overall functional status, and increased likelihood of chronic illness; food insecurity is also paradoxically associated with being overweight in some studies, likely owing in part to the extremely poor nutritional value of many low-cost convenience foods (Olson 1999; Vozoris and Tarasuk 2003). These effects persist even after adjusting for potentially confounding variables. In the U.S., food insecurity affects an estimated 11% of households, and hunger affects roughly 3.4% of households. In Alaska, food insecurity impacts roughly 11.7% of households, and hunger affects 4.6% of households (Food Research and Action Center, 2006). There are no regional data available. However, although geographic and political differences prevent an accurate comparison, evidence from Canadian Inuit found a markedly elevated prevalence of food insecurity, at up to 49%, owing to their remoteness, dependence on potentially unreliable harvests of wild foods (both similar to Inupiat case), and poverty (a less significant problem on the North Slope) (Chan et al. 2006).

Wild foods account for roughly 50% of the caloric intake in the Alaskan Arctic, averaged over the population, and provide well over 100% of protein requirements. In 2000, the monetary value of this harvest was estimated at between $31 million and $53 million, if suitable meat were purchased in its place (ADF&G 2000). Consequently, the potential of impacts to subsistence is a likely cause of food insecurity for North Slope villages, and actual impacts to subsistence would be expected to lead to an increased prevalence of hunger. Whereas diabetes and metabolic syndromes may develop over the course of years, the problem of hunger is more immediate, and will likely occur if concurrent impacts result in failure to harvest adequate supplies of food.

Future industrial activities and climate change could cause impacts on key subsistence species, including caribou, fish, and marine mammals. The Arctic Climate Impact Assessment (ACIA) predicts marked changes in the distribution, species composition, and number of ice shelf-dependent marine mammals as a result of global warming (ACIA 2005). Development in the key subsistence areas within Northeast NPR-A will likely displace animals and may contribute to population decline if calving and spawning habitats are disturbed. Development within Northwest NPR-A and the offshore region, which could be stimulated by the construction of access routes and pipelines to the northwest corner of Northeast NPR-A, could lead to wider disruption of habitat, displacement of animals, and displacement of hunters. The projected increases in regional population could also make it more difficult for individuals and families to meet their nutritional needs through subsistence. If impacts to harvest success for multiple species occurred simultaneously, hunger could result. Sharing networks and government support programs would mitigate hunger, but if impacts to subsistence were substantial, the sharing networks might not be capable of meeting the entire caloric requirements of impacted families, and malnutrition could result.

3. Social Pathology

Rates of social pathology (including alcohol and drug abuse, domestic violence, criminal behavior, suicide and homicide) would depend on the balance between positive and negative aspects of development. Positive consequences of expanding development would include

economic opportunity; improvements in infrastructure and social and police services; employment and educational opportunity. Adverse aspects would include rapid increases in income and wealth leading to increasing economic disparity within communities, which would tend to disrupt sociocultural systems; economic depression under the "boom and bust" cycle often associated with resource development in regions with little other established economic potential; sociocultural impacts such as loss of traditionally valued subsistence lands, challenges to the viability of the subsistence lifestyle posed by multiple overlapping industrial and climactic changes, growth in the resident population, and large influxes of temporary non-Native workers into previously isolated communities; feelings of disempowerment because of loss of control over traditionally revered and critically important subsistence lands; and increased potential for drug and alcohol importation into the communities through the influx of workers and creation of new access routes.

The Inupiat people are impressively resilient and have overcome forced relocation, the decimation of the local whale population, and epidemic diseases which markedly reduced the population, all with much of their social structure and culture intact. But residents of the North Slope now are fearful that currently proposed development threatens the foundations of their way of life and health. If the viability and central importance of subsistence for these communities were eroded too far, there could be a "turning point," in which large shifts in social organization and social capital would result, with serious implications for overall health and wellbeing. While development in the planning area could constitute such a turning point for one or more villages, the cumulative impacts of all potential North Slope oil and gas and non-oil and gas development could compound this problem, and would extend outside the region directly dependent on the planning area to include the rest of the North Slope region.

It is unclear what will occur as revenues from oil development decline following the conclusion of foreseeable development. It has been suggested that communities might "readjust" by going back to being semi-nomadic hunters, but this is highly speculative. A more common pattern would be economic depression accompanied by increased prevalence of social pathology in the community, and marked increases in emigration to larger population centers. Based on the patterns seen in innumerable other communities following the conclusion of an economic boom – such as the end of the steel era in the Midwest – it is quite likely that the economic depression triggered by the conclusion of development activities could trigger large-scale social problems with the resultant increases in health problems related to social pathology.

4. Injury

As discussed previously in **sections 3.4.10 and 4.3.19**, injury rates are driven by two factors: the difficulty of subsistence conditions, and problems related to social pathology, such as alcohol and drug use, domestic violence, suicide, and homicide. The cumulative effects on social pathology and subsistence are described above. If social pathology increases, there will be a predictable increase in unintentional and intentional injuries, reflecting more prevalent alcohol and substance abuse as well as increasing risk-taking behavior. Similarly, the predicted displacement of subsistence resources will likely make it necessary for hunters to travel longer distances; in the case of whaling, hunters have observed more unpredictable and aggressive behaviors among whales disturbed by seismic activity. These conditions would also favor a trend toward higher injury rates.

5. Health Problems Related to EPA Criteria Pollutants

Most of the emissions from North Slope development have to date been concentrated in the region of Prudhoe Bay. Emissions from Prudhoe Bay have been detected in Barrow (Jaffe D, Honrath R et al 1995), but monitoring data are not sufficient to allow determination of the

contribution of current oilfield emissions to air quality in Barrow or other villages remote from Prudhoe Bay, relative to the contributions of other known sources in Northern Europe and Asia. The EPA Criteria Pollutants have been associated with an array of health effects, the most common and significant of which include causing and exacerbating respiratory illnesses such as asthma; increased risk of cardiac arrhythmias; exacerbated atherosclerotic coronary artery disease; and excess overall mortality among vulnerable groups. According to the EPA, $PM_{2.5}$ in particular is associated with "increased respiratory symptoms, such as irritation of the airways, coughing, or difficulty breathing, for example; decreased lung function; aggravated asthma; development of chronic bronchitis; irregular heartbeat; nonfatal heart attacks; and premature death in people with heart or lung disease" (EPA 2005). There are no available data for North Slope production or concentrations of fine particulate (PM 2.5). According to EPA analysis and several independent studies, substantial health effects accrue at even levels below NAAQS standards, down to ambient levels (Ostro et al 2006; USEPA 2006b). The health effects include higher overall mortality rates and higher loss of 'quality adjusted life years,' a measure which takes into account time lost from illness. From the standpoint of the North Slope population, one of the most important findings of these data is that the impacts fall disproportionately to vulnerable populations (elderly, very young, and people with chronic illnesses). Given the baseline health disparities described in **section 3.4.10**, then, North Slope communities would face substantial risk from increased particulate emissions, even if air quality continued to meet NAAQS standards.

According to the assumptions made for cumulative impact analysis, future development would be decentralized, occurring over a broader region and closer to current population centers and subsistence areas. Because of the closer proximity of development to current population centers, some villages might experience decreases in air quality on an ongoing basis, depending on the level of development activity from on and offshore projects. However, the more likely scenario would be the increased likelihood of intermittent poor air quality events in or near villages or subsistence areas due to local emissions. Such events might become more common during temperature inversions or when wind conditions favor entrainment of pollutants toward population centers. Isolated low air quality events would be expected to trigger more frequent episodes of respiratory symptoms, cardiac problems, and increased mortality among elders and other vulnerable groups, but would not likely add substantially to the overall prevalence of pulmonary disease. The extent to which this occurs will depend both on the timing of development (i.e. multiple projects occurring simultaneously vs. spread over decades), and the degree to which developers apply the best available control technology.

6. Health Problems Related to Environmental Contaminants

Airborne contaminants (other than the Criteria Pollutants discussed above) are categorized as Hazardous Air Pollutants (HAP), a diverse group of pollutants with an array of health effects including an etiologic role in certain cancers, cognitive and neurodevelopmental delays, endocrine disorders, and immunological problems (Jacobsen et al 1996; EPA 2007; AMAP 2003; Cone 2005). HAP can contact human populations either directly through emissions, or through the food chain. Public health data support the link between contaminants which can be associated with oil and gas development, and the risk of cancer, endocrine, and cognitive disorders (Jacobsen et al 1996; Arctic Monitoring and Assessment Program 2003; Cone 2005). However, the small size of the North Slope population and the bioaccumulation of contaminants from worldwide sources render precise attribution of the contribution of local industrial activity to contaminant-based health problems extremely difficult, outside of a scenario such as large-scale contamination occurring through a large oil spill.

A primary route through which contaminants would reach the human population in the North Slope is through subsistence foods. Current data suggests that the subsistence food supply in the North Slope is quite safe, although residents are concerned that the established safety standards for contaminant levels were not established with consideration for the vastly larger quantities of wild game consumed by residents in the region. The NSB has maintained an extensive program of monitoring and testing subsistence resources for contaminants. The results have been encouraging, in that to date, the levels of contaminants such as PCBs in subsistence foods have been substantially lower than those reported in similar resources in Canada and Greenland. One important study also documented the presence of PCBs in store-bought foods, and made the point that there is no available food source which prevents exposure to such contaminants altogether (O'Hara 2005). The Alaska Department of Health has also summarized data on PCBs and mercury in subsistence foods, and concluded with a strong recommendation that people continue eating subsistence foods because given the relatively low levels of contaminants present, the health benefits clearly outweigh the risks (Alaska Department of Health 2004a and 2004b).

As oil and gas development operations expand through the region, potential sources of contamination will occur closer to population centers and subsistence areas, both on and offshore, raising the potential that hunters will contact contaminated resources.

The question of causation in illnesses such as cancer and neurodevelopmental delay is complicated by the host of genetic, behavioral, and environmental factors that can contribute to these problems, and the limited data regarding levels of locally produced contaminants. Furthermore, contaminants in the Arctic derive from worldwide sources, not only local emissions. Finally, the small numbers of people in each village render valid epidemiologic studies difficult or impossible to design. Hence, it will be extremely difficult to unravel the complex pathogenesis of these problems to fully elucidate the contribution of oil and gas activities to overall rates.

7. Infectious Disease

As discussed in **sections 3.4.10 and 4.3.19**, the North Slope population has several areas of vulnerability to infectious disease. The prevalence of pulmonary disease is relatively high, and people with chronic pulmonary disease are particularly at risk from respiratory infections; rates of HIV and syphilis are substantially lower in the North Slope than in the Alaskan and U.S. general population (Alaska Department of Public Health 2002 and 2005); Chlamydia rates are much higher in Alaska Natives than non-Natives in Alaska – there are no North Slope-specific data available at this time (Alaska Department of Public Health 2006). Many health care providers in the region commented that the North Slope community appears particularly vulnerable to respiratory infections. This observation has been made in other coastal Alaska Native populations as well (Singleton, Bruden et al. 2006).

As oil and gas activities expand toward other villages, there will be increasing activity in and near villages which have been relatively isolated. For example, activities projected under MMS lease sale 193 would likely involve a base of operations in or near Wainwright. The large influxes of workers into previously isolated villages, and increasing contact between Inupiat residents and the immigrant population of oil workers would increase the likelihood of disease transmission. Conditions in oil and camps (large numbers of people living and working in a relatively small enclosed area) favor transmission of pathogens, and could serve as a "reservoir" for transmission to the communities.

8. Social Determinants of Health

Many of the effects on social determinants have been discussed above in the analysis for specific health problems. This analysis serves as a summary of the ways in which industrial development in the region may impact factors which underlie the current health status and prevalent health disparities in the North Slope Inupiat community.

Foreseeable oil and gas leasing both on and offshore on state, Federal, and Native Corporation lands will continue to be one of the dominant forces influencing socio-economic conditions on the North Slope. As outlined in the analysis of the alternatives and in Table 4.3-D, socio-economic conditions are powerful determinants of health status, and are felt to underlie many of the current health disparities between groups of different ethnicity and income levels in our society (Wilkinson and Marmot, 2003). As outlined in the analysis of the alternatives, these effects may manifest at a statewide, regional, or local level. The westward spread of industrial activity postulated for the cumulative impact analysis would bring disturbances such as an influx of outside workers, changes in employment and income, and displacement of subsistence resources to a wider region, with effects on villages such as Wainwright which have not yet experienced local oil exploration and development activities. Positive effects on the social determinants of health would likely include increased employment opportunities, increased incomes, and a continued revenue stream to maintain community infrastructure, sanitation, housing, and public health systems. Adverse effects on the social determinants of health would include, for example, increased stress owing to anxiety over actual and potential impacts to subsistence resources; rapid acculturation; increased economic disparity; a worsening of the social gradient owing to loss of control over traditional lands; and decreasing social capital if subsistence sharing networks are disrupted by reduction in subsistence harvests. The analysis of health impacts through the social determinants framework allows identification of both adverse and beneficial aspects of development, at a statewide, regional, and local level. Beneficial and adverse effects of development may occur simultaneously.

The abandonment of oil fields and related loss of revenue would likely be associated with a period of economic recession and job loss. Other potential sources through which income might be maintained near current levels have not been identified. Impacts to the social determinants of health would include stress and decreased job security; and recession associated with emigration. In this cumulative impact analysis, it is anticipated that there could be impacts to the social determinants of health through oil and gas-related disturbances to subsistence, sociocultural systems, economy, employment, and environmental quality, as well as through non-oil and gas-related disturbances such as global warming.

Oil and gas development has become a dominant socio-economic force on the North Slope, producing influences through, for example, acculturative pressures secondary to large numbers of workers from a different culture entering previously isolated Inupiat villages; stress over perceived and actual threats to culture and subsistence; direct and indirect employment opportunity; and broad economic and infrastructure improvements. It is important to recognize that the potential changes brought by oil and gas development may create statewide, regional, and local (village-level) effects, as described above. Furthermore, it must be understood that effects on the SDH may create concomitant positive and negative effects on health status. Local and regional SDH effects may be the most important to recognize because effective strategies for mitigation may be devised more readily (see, for example, Assai et. al 2006). For example, a local increase in employment may create both benefits through economic opportunity and adverse effects because of tensions between the imperative to provide for one's family through subsistence activities and the pressure to be a successful wage earner. Mitigation could be targeted at efforts to devise flexible work schedules which allow participation in both activities.

4.7.7.19.3 Global Climate Change

Global climate change will likely cause substantial changes to the physical environment including flooding, salinization of coastal wetlands and lakes, markedly increased erosion, weakening of the shorefast ice and retreat of the polar ice cap, and a shorter winter season. Health effects associated with global climate change were reviewed extensively by the Arctic Climate Impact Assessment. Projections included the possibility of decreased cold-related injury and decreased overall mortality, the potential for increased heat-related injury in the summer, increases in vector-borne infectious diseases, and increased UV-related malignancies owing to thinning of the ozone layer. Large-scale changes to the distribution and species available for subsistence could lead to dietary change, and potentially to food shortages, with the resultant potential for increases in metabolic disorders, food insecurity, and hunger. Sociocultural stresses resulting from the loss of traditional activities (for example spring whaling) and influx of new commerce and shipping due to ice-free summer waters could lead to increases in social pathology. Water supply, sanitation, and village infrastructure are major concerns, as many northern coastal villages are already experiencing marked erosion and several villages (though not yet on the North Slope) are actively seeking to relocate. As erosion accelerates, water supplies may be breached; there may be more flooding and flood-related damage; and there may be breaches of sanitation systems and hazardous waste containment systems leading to water contamination (ACIA 2005).

The degree to which these changes occur will depend on complex interactions between climate change, changes in the distribution of subsistence species, and socio-cultural forces which are difficult to predict with accuracy. In as much as rapid socio-cultural change is a well-documented stressor, it is very likely that climate change will contribute substantially to stress and related illnesses in the coming decades.

4.7.7.19.4 Contribution of the Supplement Alternatives to Cumulative Effects

Oil and gas development in Northeast NPR-A may contribute to cumulative public health effects in a number of ways. Under Alternatives B-D, development would be allowed throughout most of one of the prime subsistence areas in the region, and there is a substantial chance that subsistence harvests may decline as a result of development, primarily because of displacement of subsistence resources or hunters. This could also occur for Alternative A, but to a lesser degree because of prohibitions on leasing within substantial portions of the TLSA. Under Alternatives B-D, development in the northeastern portion of Northwest NPR-A, as well as areas offshore of Northeast and Northwest NPR-A, could be stimulated by the establishment of pipelines and infrastructure in the planning area. Hunters from Nuiqsut could have to pass through or near oil and gas infrastructure in almost every direction to get to subsistence areas. Experience from the present day shows that most hunters are unwilling to do so, and it is therefore uncertain what will happen with Nuiqsut's subsistence practices if development occurs in the planning area. If subsistence harvests decline, the population would be at risk for further increases in diabetes and metabolic disorders as well as food insecurity and, potentially, hunger. Stress and acculturation pressures resulting from the influx of oil workers and concerns about subsistence traditions could lead to increases in social pathology. Injuries would likely increase somewhat in relation to the more difficult subsistence conditions. The contribution of contaminants produced within the planning area to overall rates of cancer, metabolic diseases, and respiratory diseases is more difficult to evaluate because of the limited air quality data existing on the North Slope, and because of the accumulation of contaminants in the Arctic from worldwide sources. The influx of outside employees to the region would be associated with an increased risk of infectious disease transmission.

4.7.7.19.5 Conclusion

Inupiat health status is evolving rapidly. Chronic diseases, metabolic disorders, and cancer are becoming more common, and social pathology appears to have increased fairly sharply over the last 50 years; social pathology is now considered epidemic, and is a matter of great concern to residents and the public health community. On the other hand, overall life expectancy and mortality rates have declined, owing in large part to changes in sanitation, infection control, and infrastructure leading to lower rates of infectious diseases. Injury rates, though still markedly higher than the general U.S. population, have declined somewhat (Day et al. 2006, Goldsmith et. Al 2004). Overall, despite substantial improvements in health status, significant disparities in overall mortality rates, as well as rates of specific problems such as cancer, injury, and social pathology. Infectious disease distribution and prevalence will evolve under the combined influences of globalization, climate change, the projected increases in regional population, and local influx of workers for oil and gas projects. Because HIV prevalence in this fairly isolated region is currently low, efforts to prevent transmission may be particularly beneficial.

As one of the primary drivers of North Slope socio-economic conditions, oil and gas activities are important determinants of health. Development on and offshore will continue to be a major driver of the local economy for decades to come, and the ultimate decline in oil revenues will also be a major force shaping socio-economic conditions. Under the cumulative impacts of climate change and expanding oil and gas activity, it is very likely that subsistence resources and hunters will be displaced from currently productive areas. As discussed in **section 4.8.13**, this could result in profound changes to the social structure in Inupiat communities; if the cumulative developments result in a shift away from subsistence as a way of life, metabolic disorders including diabetes, hunger and food insecurity, social pathology, and injury would likely increase. The health care and social services available through ASNA, NSB, state, and Federal programs would mitigate some of these impacts through intervention and treatment, but would not prevent these problems from occurring.

4.7.8 Cumulative Effects Outside of the Planning Area from the Transport of Northeast National Petroleum Reserve – Alaska Produced Oil

Oil that may be produced from Northeast NPR-A under any of the alternatives considered in this Supplemental IAP/EIS would be mingled with oil from Prudhoe Bay and other existing and potential future North Slope oil fields before passing through the existing TAPS to Valdez. From there, oil would be placed in tankers to be taken to market. The Department of Energy currently estimates that Alaska's oil production, nearly all of which originates on the North Slope, will decline from 860,000 barrels/day to 270,000 barrels/day in 2030. (DOE, Energy Information Administration, Annual Energy Outlook, 2007, p. 95) Depending upon how much additional oil is produced from NPR-A and other future North Slope oil development, these projected production declines may be slowed, or perhaps at some point even reversed. TAPS has excess capacity sufficient to handle additional oil, though MMS indicates that if a very large Chukchi Sea development began to produce oil, some upgrades in the TAPS pipeline and pump stations would be needed because some pump stations have been idled because of dropping throughput. Addition of planning area oil to future tanker shipments may also slow, or perhaps at some point reverse, the decline in tanker traffic that is inherent in the declining oil production anticipated by the Energy Information Administration. Whether oil from the planning area ultimately helps to reverse dropping North Slope production or just slows its

decline, however, oil from the Northeast NPR-A may serve to extend the economic life of TAPS and use of marine tankers to deliver that oil to market. By making TAPS and the tanker system economically viable for a longer period, planning area oil (along with other potential future oil development) may also extend the period that other oil fields may economically produce oil. The following analysis is provided to describe the impacts that NPR-A oil may have by helping to extend the life of the TAPS and the tanker system that brings North Slope oil to market.

BLM analyzed the impacts of operating TAPS over the next 30 years, including production from NPR-A, in the Final EIS Renewal of the Federal Grant for the Trans-Alaska Pipeline System Right-of-Way (USDOI BLM 2002a). The TAPS EIS assessed most impacts of the pipeline as small, localized, and short term. Vegetation and soils would be disturbed in very small areas along the 800-mile-long pipeline, and the risk of affecting paleontological or cultural resources was assessed as very remote. Impacts on subsistence and human health would be small, although the EIS estimated that over the course of the next 30 years there could be six fatalities and less than a hundred time-loss injuries to workers. Impacts on air, water, fish, birds, and mammals would all be small, except in the event of an unlikely large spill. Oil spills could create temporary public health risks to people in the immediate vicinity. Large oil spills could have substantial impacts on groundwater, surface water, and the marine environment. A large spill into certain water bodies could, depending on the circumstances, cause severe and possibly long-term impacts to fish. A very large spill, or one that contaminated a crucial habitat, would also be the only means by which impacts to bird or mammal populations would likely occur.

The cumulative effects of transporting Alaska North Slope oil (which would include oil produced from the Northeast NPR-A) by tanker from the Port of Valdez to the U.S. West Coast and Asian markets were evaluated in the Liberty Development and Production Plan Final EIS, which is incorporated by reference (USDOI MMS 2002a). The analysis estimated the number of cumulative tanker spills to be nine, including six spills with an average size of 3,000 bbl (four of which would occur in port and two of which would occur at sea), two spills with an average size of 13,000 bbl (both of which would occur at sea), and one spill of 200,000 bbl (at sea in the Gulf of Alaska). It was predicted that the six spills at sea and the one larger spill would not occur within the same location or contact the same resources before recovery of the affected resource. In-port spills, for which contingency measures would be in place, would be cleaned up relatively quickly. Spills originating 80 to 100 miles offshore would have a 5 to 10% chance of contacting the shore within 30 days. Weathering and dispersion of the oil during this time would reduce effects. When past effects have been studied, spills of 13,000 bbl or less at sea have not been found to cause serious effects to birds, fish, or marine mammal populations. A spill along the route to Asian markets would be expected to move parallel to the Alaska Peninsula and the Aleutian Island chain. Production from the planning area would account for approximately 13% of the total reasonably foreseeable future volume of oil moved to port via TAPS.

The TAPS analysis predicted few, if any, effects to threatened and endangered species from a tanker spill. For example, bowhead whales and their habitat are far removed from the tanker routes; spectacled eiders do not occur in the area that could be contacted by oil; and an oil spill would be unlikely to reach either the densely populated Steller's eider wintering area or northern sea otters and their habitat along the Alaska Peninsula or Aleutian Island chain. Potential effects to salmonids and other fish species, including the tidewater goby, Sacramento splittail, Pacific hake, white abalone and black abalone, appear limited. An oil spill in Prince William Sound or the Gulf of Alaska could have cumulative effects on sea otters in those areas and local effects on harbor seals.

Only a very large, 200,000-bbl spill could cause serious effects to marine and coastal birds in the Gulf of Alaska. An oil spill in Prince William Sound could have local, cumulative effects on river otters and brown and black bears in the area. A spill could affect lower-trophic level organisms, such as plankton, algae, and seaweed that experienced contact. A 200,000-bbl spill could affect commercial fishing and result in an economic loss ranging from 37 to 64% per year for 2 years in the area affected by the spill. Smaller oil spills would not be expected to have measurable effects on fish species (including anadromous species) or result in measurable effects on sport fishing. If oil contact were to occur, wetlands in Prince William Sound and along west coast routes to Seattle, San Francisco Bay, and Los Angeles could experience local, cumulative effects from contact and damage caused by clean-up operations. Subsistence harvest for residents of Cordova and Yakutat, Alaska, could be reduced or altered, especially if the 200,000-bbl spill contacted and caused serious, long-term effects to sea otters, coastal birds, and harbor seals. Similarly, economic losses to the commercial fishery described above would also represent a serious loss to the subsistence fishery. A spill of that magnitude would also cause serious institutional stress and disruption to associated sociocultural systems in Cordova that could last for 4 years, with lesser effects on Yakutat. These effects would be similar to the effects experienced by these communities as a result of the Exxon Valdez oil spill. Archaeological resources in an area contacted by oil spills could be affected by clean-up activities, oil contamination, and vandalism, although protocols are in place to identify sites and minimize impacts from cleanup. A 200,000-bbl spill could create 10,000 cleanup-related jobs for 6 months in the first year, declining to zero by the fourth year following the spill, along with local price inflation of up to 25% during the first 6 months following the spill.

Effects to water-quality would vary with the location and size of the spill. Generally, the concentration of hydrocarbons in the water column would be high during the first several days following the spill, decreasing over time to background levels. While overall air quality effects from tanker transportation would be considered low, an oil spill could result in localized increases in ambient VOC concentrations caused by spill evaporation.

The potential effects of a 200,000-bbl oil tanker spill along the TAPS tanker route were analyzed in the Gulf of Alaska/Yakutat Planning Area Oil and Gas Lease Sale 158 EIS (USDOI MMS 1995b). The 1998 Northeast IAP/EIS used that information to analyze tanker spills occurring from production in the planning area (USDOI BLM and MMS 1998:Appendix B). That analysis affirms the conclusions (summarized above) of the Liberty EIS and is incorporated here by reference.

4.8 UNAVOIDABLE ADVERSE EFFECTS

This section summarizes the unavoidable adverse environmental effects that would occur under the alternatives considered in this amendment. Under the alternatives, the land allocations for oil and gas leasing range from making all BLM-administered lands in the planning area available for leasing (Alternative C) to making approximately 87% of lands available for leasing (Alternative A). Unavoidable adverse effects would be expected to occur during oil and gas exploration, development, and production operations. Many of the adverse effects identified in this section would occur only if a large oil spill were to occur.

4.8.1 Air Quality

An increase in emissions of air pollutants would occur as a result of all alternatives. In all the alternatives and the cumulative case, the projected emissions would be less than emissions that have occurred due to North Slope oil and gas activities in the past when production rates were much higher. For all alternatives, established air quality standards would not be violated.

4.8.2 Paleontological Resources

Although paleontological resources are nonrenewable, invertebrate fossils are so common as to be ubiquitous throughout the planning area and petroleum exploration and development activities are not considered a significant threat to them. The loss of vertebrate paleontological resources, however, has the potential to be adverse, especially if it results in the loss of scientifically important fossils. However, if surveys and inventories in areas of proposed oil and gas exploration and development activities were conducted before work began and avoidance of vertebrate paleontological locales was possible, the incidence of impact would be greatly reduced and any impacts would be minimal. Lease stipulations and ROPs that restrict or prohibit oil and gas drilling and development in streams and rivers would reduce the likelihood of impacts to vertebrate paleontological resources in the planning area. Additionally, strict enforcement of lease stipulations requiring non-collection of vertebrate fossils also would avoid adverse impacts to paleontological resources. Included in these lease stipulations would be a mandatory training program for the workers on the importance of preserving and not collecting vertebrate paleontological resources.

4.8.3 Soil Resources

While impacts to soils from exploratory drilling would occur over a small area, relative to the overall planning area and ACP, these impacts would be unavoidable and permanent. Development activities, such as the construction of permanent gravel roads and pads, could cause damage or loss of soil over the area affected. Construction of any oil and gas pipelines or the use of a gravel mine site would also permanently disturb or destroy soil in the immediate vicinity of the project. If a crude or refined oil spill occurred, the resultant impact to soils could extend beyond the immediate work area. Lease stipulations and ROPs, however, would reduce the majority of effects. Some soil would be restored as sites are abandoned and reclaimed. However, due to the harsh Arctic climate, it could take several hundred years for soil productivity to reach pre-disturbance levels on abandoned pads and roads.

4.8.4 Water Resources

Activities from road and pad construction could produce unavoidable adverse effects to water resources. For example, culvert and bridge work in streams and lakes could disturb stream banks, stream beds, or shorelines; blockages of natural channels and floodways could disrupt drainage patterns; and removal of gravel and water from riverine pools and lakes could increase erosion and sedimentation. Because roads would pose the single most critical impact to water resources because of the diversions, impoundments, and increased sediments runoff they would create, limiting the length of the roads would be the most effective way of reducing impacts to water resources.

Construction would result in short-term subsidence of the ice-rich permafrost along stream banks and lakeshores, especially in areas where waves would accelerate the removal of the protective soil and vegetative cover. Fine-grained sediments melting out of the ice-rich permafrost would increase sediment erosion and the associated changes to stream channel morphology.

Unavoidable adverse effects on water quality could occur from spills, and from construction of ice roads and gravel pads, airstrips, and roads. Lease stipulations and ROPs have been developed to minimize the risk of spills, and to provide for spill cleanup. Construction disturbances would be permitted (approved) after subsequent environmental reviews; therefore, impacts could be minimized or avoided. As noted in NRC (2003), the oil industry and regulatory agencies have made substantial progress in slowing the accumulation of effects of gravel fill by reducing the size of the footprint required for facilities and substituting ice for gravel in some roads and pads. Several lease stipulations and ROPs include requirements and standards to minimize the amount of area of surface disturbance.

Unavoidable adverse effects on estuarine water quality would occur from offshore ice-road and ice-pad construction and petroleum-related spills. The construction would have very localized, short-term effects on estuarine water quality.

The construction of coastal staging facilities would have unavoidable adverse effects on estuarine water quality. Construction disturbances would be permitted (approved) after subsequent environmental reviews; therefore impacts could be minimized or avoided. Construction would have very localized, short-term effects on estuarine water quality, while spills could have a longer-term impact on marine waters.

4.8.5 Vegetation

All of the direct impacts to vegetation described for all alternatives would be unavoidable. Seismic activities, overland moves, and exploratory drilling would occur during the winter when the ground is frozen and snow-covered. Such activities could cause impacts that linger from one year to decades, in the form of vegetation that appears greener than surrounding areas, shallow water tracks, ponding, scuffed or crushed tussocks, and ruts through tussocks. Impacts caused by oil/gas field development, such as burial of vegetation under gravel fill and contamination by oil spills, would be unavoidable, direct adverse effects. Placement of gravel drilling pads, roads, airstrips, staging areas, and docks, as well as construction of oil and gas pipelines and the use of gravel mine sites, would permanently disturb or destroy soil and vegetation. Additionally, vegetation and soils may be disturbed by the formation of impoundments where gravel structures alter drainage patterns. Changes in plant community composition, such as those caused by snowdrift and dust accumulation, would account for about 75% of the area impacted

by oil/gas field development. Impacts from moisture regime changes would have an adverse effect on the original plant community and its associated fauna, but perhaps a beneficial effect on the plant communities that colonize those areas.

4.8.6 Wetlands and Floodplains

Biological resource areas that can be classified as having the function and value of wetlands and floodplains on the North Slope include vegetation, soils, and water resources and quality. Please refer to the discussions in this section for each of these resources for information on unavoidable adverse effects on wetlands and floodplains.

4.8.7 Fish

4.8.7.1 Freshwater and Anadromous/Amphidromous Fish

Unavoidable adverse effects to freshwater and anadromous/amphidromous fish would include short-term avoidance behavior and stress related to seismic vibration activity; loss of habitat and reduced productivity created by gravel excavation in spawning, rearing, and overwintering areas; degradation and loss of habitat and mortality of fish eggs and larvae from erosion and sedimentation in streams and lakes; and lethal and/or sublethal effects to fish from oil spills. Oil-spill cleanup activities could compound unavoidable adverse impacts to fish habitat; however, the effects would be unlikely to measurably impact fish populations in the region.

4.8.7.2 Marine Fish

Unavoidable adverse effects to marine fish would occur as a result of seismic surveys, construction in or near marine waters, marine vessel traffic, and oil and fuel spills. Seismic surveys in overwintering areas could have lethal effects on some juvenile fish overwintering there. The construction of a coastal docking facility to offload supply barges adjacent to the planning area would affect the movement of some coastal marine and migratory marine fish. The severity of the effects of a docking facility would depend on its location, size, and design characteristics, and whether the facility required an offshore access causeway. Marine vessel traffic used to support onshore industrial activities could temporarily disturb fish. It is possible that a very large spill (≥ 120,000 bbl) could affect the marine fish population in the immediate area, and this could require approximately 3 to 10 years for recovery.

4.8.8 Birds

Some disturbance of birds in the planning area by routine activities and oil and gas development would be considered unavoidable. Disturbance related to aircraft traffic (such as aerial wildlife surveys and aircraft support of camps or oil and gas facilities), vehicle and pedestrian traffic would be likely to have the greatest impact on birds.

The potential effects of routine aircraft flights into airstrips would range from bird avoidance of certain areas to abandonment of nesting attempts or lowered survival of young. The likelihood that noise associated with aircraft would have a negative impact on birds would probably be greatest during the nesting period when the movements of incubating birds are restricted and the molting period when birds may be energetically stress and are know to be sensitive to disturbance. Derksen et al. (1992) reported that molting brant in the Teshekpuk Lake Goose Molting Area were disturbed by helicopter overflights and that brant did not habituate to the

overflights. Low-level helicopter survey flights to monitor pipelines for potential oil spills or leaks could also disturb tundra-nesting or post-breeding birds. Routine flights would be of short duration and occur in a particular area, and would likely cause minimal disturbance to birds. However, temporary displacement from preferred feeding, brood-rearing, or molting habitats could affect energy budgets of some birds, and incubating birds could be temporarily displaced from nests potentially allowing abandonment of nesting attempt and allowing predators greater access to eggs or young. Some aircraft disturbance to molting and migrating loons and waterfowl in marine habitats would be unavoidable. Given that there are a limited number of staging areas along the North Slope, birds may have few options for moving to new areas that provide comparable resources (Andres and Gill 2000; Flint et al. 2003). Aircraft flights over the Colville River Delta during the fall could impact thousands of shorebirds staging in this area prior to migration. This may be especially problematic for dunlins, the most common staging bird in the area, as they are also undergoing an energetically expensive, premigratory molt at this time.

The presence of roads and pads and activities associated with oil and gas development could also cause unavoidable disturbances that affect tundra-nesting birds. The primary sources of disturbance related to roads and facilities would result from vehicular traffic, heavy equipment use, routine maintenance activities, oil spill response training activities, and pedestrian traffic. These disturbances could result in temporary or permanent displacement from preferred foraging, nesting, and brood-rearing, molting and staging habitats, decreased nest attendance, nest abandonment, nest predation and increased energy expenditures that could affect the physiological condition of birds and their survival or reproduction. The likelihood for impacts to tundra-nesting birds would vary depending on the type and location of the disturbance, the species and number of individuals in the area, and the time of year. Impacts would be most likely to occur if facilities were located in habitats with high bird concentrations, in areas containing species that are vulnerable to small losses of nests and habitats that may be limiting for a particular species or if species with low population numbers or declining populations were disturbed. Impacts would be most important if disturbances were to occur in areas of high bird use such as the goose molting area north of Teshekpuk Lake.

It is unknown but likely that habitat would not be a limiting factor for most species nesting in the planning area and that many birds displaced by disturbances related to oil and gas development would move to adjacent habitats. In addition, vessel traffic along river systems or in marine habitats could cause temporary displacement of some birds from preferred habitats. Lease stipulations and ROPs would help to mitigate many of the effects of disturbance to tundra-nesting birds, but some impacts may be unavoidable. There would also be a permanent loss of bird habitat associated with the construction of gravel roads, pads, airstrips, staging areas, pipelines, and gravel excavation sites. The extent of disturbance or habitat loss on tundra-nesting birds would be related to the location and timing of the disturbance or habitat loss and the species and number of individuals in the immediate area. While it is likely that many birds would move to adjacent habitats, some impacts related to habitat loss could be unavoidable.

4.8.9 Mammals

4.8.9.1 Terrestrial Mammals

Some disturbance and disruption of caribou and some habitat alterations from oil development under all alternatives are unavoidable. Displacement or reduced habitat use by the TLH, WAH, and CAH caribou are likely to be local (within 2 to 2½ miles of oil field roads and pipeline

corridors) and long term (greater than 1 generation), and could persist over the life of the oil fields. For the TLH, this could result in a shift of the concentrated calving area, if development occurred within that area. Some noise and disturbance of other terrestrial mammals would be unavoidable, but would be short term and localized and would not substantially affect mammal populations.

4.8.9.2 Marine Mammals

Increased barge traffic associated with development could displace migrating whales and possibly other marine mammals depending upon the timing and location of vessel traffic. However, such impacts could be mitigated by limiting vessel traffic during migration periods. The construction of a coastal docking facility to offload supply barges adjacent to the planning area could affect seal habitat. The severity of the effects of such a docking facility would depend on its location, size, design characteristics, and whether the facility required an offshore access causeway. Marine vessel traffic used to support onshore industrial activities could temporarily disturb marine mammals. Increased air traffic may also result in disturbance to marine mammals, particularly in the near shore areas.

4.8.10 Threatened and Endangered Species

Disturbance from noise produced by marine vessel traffic supporting oil and gas activities in the planning area could be unavoidable, should bowhead whales be migrating past the northern planning area boundary. Increased barge traffic associated with development could also displace migrating whales, depending upon the timing of vessel traffic. However, such impacts could be mitigated by limiting vessel traffic during migration periods. Because vessel noise alone is likely to result in only minor changes in whale behavior (Richardson 1999), disturbance from such vessel activity would probably not preclude whale migration or disrupt feeding activities on a long-term basis.

Some disturbance to nesting, brood-rearing, staging, or migrating spectacled and Steller's eiders by routine activities associated with oil and gas exploration and development is considered unavoidable. The types of disturbances that could affect threatened eiders are the same as those discussed above for birds and include vehicular, vessel, and aircraft traffic, heavy equipment use, routine maintenance activities, oil spill response training activities, and pedestrian traffic. The impacts to threatened eiders from these disturbances would also be similar to those described above for birds. Because of their threatened status and ROP E-11, research activities would be conducted prior to and during development of oil and gas production facilities. These research activities would involve helicopter and fixed-wing aircraft, as well as ground-based activities that could cause disturbances affecting eider nesting and brood-rearing activities. Impacts to eiders could be even greater if disturbances occurred in areas of high eider use such as the tundra ponds north of Teshekpuk Lake. Eiders may habituate to some disturbances or could move to alternate habitats for foraging, nesting, and brood-rearing. There would also be a permanent loss of eider habitat associated with the construction of gravel roads, pads, airstrips, staging areas, pipelines, and gravel excavation sites. Depending upon where development occurred within the planning area, such loss could affect habitat preferentially used by threatened eiders.

Lease stipulations and ROPs would effectively mitigate many of the effects of disturbance to spectacled and Steller's eiders, but some impacts could be unavoidable. BLM expects most disturbances of endangered and threatened species associated with routine activities to be

minimized or avoided through compliance with mitigation measures developed through the ESA Section 7 consultation process.

Seismic surveying, air, vessel, and ice road traffic, and construction activities would unavoidably disturb a few polar bears and their prey (seals), but this effect would be very brief and would not affect bear population abundance or overall distribution in the planning area. ROP C-1 would require avoidance of dens, and polar bears remain protected under the Marine Mammal Protection Act. Provisions under the MMPA require lessees to obtain Letters of Authorization that direct them to avoid disturbance to polar bear dens and require the use of non-lethal means to avoid human-bear interactions.

4.8.11 Cultural Resources

Cultural resources are nonrenewable and not numerous in the planning area, so any effects would have some importance. Because the exact locations of all potential cultural resources sites are unknown, their disturbance cannot be entirely avoided. There are cultural resources within the planning area that may relate to the entire span of human occupation of the region, including locales relating to the first humans to enter the Western Hemisphere. Historic and prehistoric sites may be located anywhere within the planning area and represent varied ages, cultures, and functions. Because soil forms slowly in the Arctic, sites that are thousands of years old may be near or on the surface. If surveys and inventories for cultural resources in areas proposed for oil and gas exploration and development were conducted before the work began, then the effects to cultural resources in these areas would be reduced or avoided. Timely intervention following the discovery of cultural resources would effectively mitigate many effects, either through site avoidance or data recovery. Salvage archaeology to recover remaining site data from a disturbed site would result in the total destruction of the site, although the recovered data would, in most cases, effectively mitigate for this destruction.

4.8.12 Subsistence

Bowhead whales, caribou, fish, seals, birds, wolves, and wolverines are important subsistence resources for NSB residents. Noise and disturbance from seismic surveys, exploration, development, and production could affect the harvest of subsistence resources in the communities of Anaktuvuk Pass, Atqasuk, Barrow, and Nuiqsut. Additionally, disturbance could cause potential short-term impacts to long-tailed ducks and some eider populations. No harvest areas would become unavailable for use, but many subsistence users would avoid areas of oil development because of regulatory exclusion (real or perceived), and potential for contamination of species.

While noise, traffic disturbance, and oil spills would produce chronic, short-term impacts on subsistence species, none of these impacts would lead to the elimination of any subsistence resource. Disturbance to, and displacement of, caribou could lead to an unavoidable reduction in the total annual caribou harvest by making the harvest more difficult, costly, and time consuming for subsistence hunters. Wolf and wolverine harvests would be reduced in areas of human activity, while bear and fox could habituate to oil and gas activities within the planning area. Effects on the harvest of other species from noise and traffic disturbance, and construction activities should be avoidable, if mitigated. If oil and gas infrastructure were located in subsistence hunting areas, some (real or perceived) restrictions on access by subsistence hunters would be unavoidable.

4.8.13 Sociocultural Systems

The inability to harvest sufficient quantities of bowhead whales as a result of disturbance could cause unavoidable effects on Iñupiat traditional harvesting and sharing practices. These effects would increase if the harvest shortage lasted more than one whaling season. Disturbance effects on caribou could disrupt sociocultural systems for an entire season or more; nevertheless, it is not expected that these disruptions would displace ongoing sociocultural institutions, community activities, or traditional practices for harvesting, sharing, and processing resources. Some cultural values, such as sharing, could be reinforced by shortages in the short term, but could be strained after several seasons of harvest shortages. Long-term harvest failures or the loss of a resource would irreparably strain the bonds of sharing and reciprocity that bind the community of Nuiqsut. The loss of the resources that Iñupiat people use to define themselves would further distance younger generations from their Iñupiat heritage and could cause profound changes in the community. Federal, NSB, and community-supported social programs with adequate funding would mitigate many of the sociocultural consequences of oil and gas development in the planning area. However, unavoidable repercussions to the communal practice of sharing of subsistence resources could occur.

4.8.14 Environmental Justice

The Environmental Justice Executive Order requires the consideration of the potential effects of proposed projects on Native subsistence activities. Noise and disturbance from routine development activities would be unavoidable. The most substantial unavoidable environmental justice effects on Native communities would be from exploration and development activities that reduced the populations or production of terrestrial mammals, water birds, and fish. These effects would primarily affect subsistence resources and would thus fall disproportionately on Native minority populations. Most other subsistence effects would be short term, local, and relatively minor, and would not be expected to raise environmental justice issues.

4.8.15 Coastal Zone Management

Activities occurring under the four alternatives are not expected to result in unavoidable adverse effects in the form of major changes in land use or conflicts with the ACMP, including the NSB Coastal Management Program. All four alternatives would likely result in short-term, unavoidable effects on subsistence activities from the change in land use in portions of the planning area from subsistence-based open space to industrial. To the extent that facilities would be sited and designed to minimize disturbance and the effects of an oil spill on the environment, conflicts with the statewide standards and the NSB policies are avoidable. It is expected that activities generally would conform to existing policies of local, state, and Federal land use plans and coastal management programs.

4.8.16 Recreation Resources

Adverse effects to scenic quality, solitude, naturalness, and primitive/unconfined recreation from oil and gas exploration and development are unavoidable. These effects would be a direct result of exploration and development activities and facilities such as drill pads and pipelines. The aerial extent of the effects would be limited to the viewshed and/or noiseshed of the development activities, leaving most of the planning area unaffected, but the impacted areas would lose their potential Wilderness characteristics for at least the life of the activity. Recent and future technological advances could make green trails and pads an avoidable impact.

Potential outstandingly remarkable values of the Wild and Scenic River eligible Colville River could be degraded by oil and gas exploration, development, and production activities, but the unavoidable adverse effects would be limited to the area(s) in close proximity to a pipeline or road crossing of the river. The effects would not alter the current status of unsuitability, but could limit the likelihood of a future change in that status.

4.8.17 Visual Resources

Unavoidable adverse effects to visual resources (i.e., the viewsheds and naturalness of the landscape) would occur from oil and gas exploration and development through the introduction of vertical lines, regular spacing, reflectivity and a greater spectrum of colors. These effects would be a direct result of oil and gas exploration and development activities and facilities such as drill pads, roads, and pipelines. Recent and future technological advances could make trails and pads an avoidable impact.

4.8.18 Economy

Most economic effects of oil and gas leasing, exploration, development, and production in the planning area would be considered positive effects by many people. Increases in employment and associated personal income would occur over the life of the exploration, development, and production activities. Revenue increases to the NSB, and to the state and Federal governments, would occur during production years. However, these increases would be short term (less than 30 years), occurring only for the duration of the activities. Development activity would establish infrastructure that could enhance the future productivity of oil and gas exploration, development, and production.

4.8.19 Public Health

Unless the trends toward higher consumption of store-bought food are reversed through effective mitigation measures that support and protect subsistence traditions and harvests, diabetes, metabolic disorders, and chronic diseases will likely continue to increase. Because the displacement of subsistence resources and hunters is anticipated even despite mitigation, injuries may increase unavoidably; this could be offset by measures targeted at increasing hunter safety. The predicted influx of workers to villages along with disruption of subsistence harvests and ongoing acculturation could lead to unavoidable increases in social problems, such as domestic violence, alcohol and drug abuse, and suicide. Because of low baseline rates of HIV, there is a particular risk of increased prevalence as contact with people from outside the region increases.

4.9 RELATIONSHIP BETWEEN THE LOCAL SHORT-TERM USES AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

This section discusses the short-term effects of the potential use of portions of the planning area for oil and gas exploration and development activities, versus the maintenance and enhancement of potential long-term productivity of the planning area's environmental resources.

Short term refers to the total duration of oil and gas exploration and production activities, whereas long term refers to an indefinite period extending beyond the termination of oil and gas production. The specific impacts vary in kind, intensity, and duration according to the activities occurring at any given time. Initial activities, such as seismic surveying and exploration drilling, generally result in short-term, localized impacts. Development drilling occurs sporadically throughout the life of an oil or gas field, but also results in short-term, localized impacts. Activities during the production life of leases executed based upon the decision in the Supplemental Northeast NPR-A ROD may result in chronic impacts over a longer period of time, potentially punctuated by more severe impacts as a result of accidental events. Facilities removal is also a short-term activity with localized impacts; the impacts of site clearance, however, may be longer lasting. Over the long term—several decades after completion of abandonment activities—natural environmental balances are generally expected to be restored, though that balance will not for all resources mean a return to the exact state prior to original disturbance.

Until more long-term study data become available, the long-term effects of chronic or major spills of hydrocarbons cannot accurately be projected. In the absence of these data, it should be assumed that chronic spills or a major large oil spill could result in decreased long-term productivity.

4.9.1 Air Quality

Air quality impacts from development, production, and transportation from each of the alternatives would be similar to those which have occurred historically. Short-term degradation of air quality related to exploration, construction, and operation would be the same as similar existing oil and gas exploration and production facilities. Air quality is a renewable resource; and, when activities that produce emissions cease, the local air quality returns to its original natural condition.

4.9.2 Paleontological Resources

Because paleontological resources are nonrenewable, there is no difference between short-term and long-term impacts. The resource cannot endure most types of adverse impacts. Once disturbed, the materials and information of paleontological deposits may be permanently compromised. Any destruction of paleontological sites, especially ones determined to have significant scientific value, would represent unrecoverable losses. Any discoveries of paleontological resources as a result of surveys required prior to development of a lease would enhance long-term knowledge of the area and these resources. Furthermore, once paleontological deposits (particularly vertebrate remains) are disturbed and exposed, natural

erosion could accelerate the destruction of fossils. Exposed vertebrate fossils also are vulnerable to unauthorized collecting and digging.

4.9.3 Soil Resources

Soils potentially affected by exploration practices cover very small areas, although up to 3,850 acres (Table 4.2-H, Alternative C) of soil would be directly impacted during development for construction of pads and roads. Additional soil would be lost when new gravel quarries are developed. Rehabilitation of soils after field abandonment could allow soils to eventually re-establish. While the formation of soils is a very slow process, short-term uses are projected to have very small long-term effects. Soils lost through the construction of permanent facilities would essentially be permanent.

4.9.4 Water Resources

Oil and gas exploration and development would result in both short-term and long-term effects to water resources. Construction activities that disturb stream banks or lake shorelines, temporarily block natural channels, and remove gravel would all cause short-term increases in erosion and sedimentation. Water removal could cause short-term changes in aquatic habitat. Permanent gravel roads and pads, airstrips, pipelines, and facilities constructed adjacent to or crossing streams and lakes would have long-term effects on water resources. Removal of these structures from streams and lakes after production ceased would restore drainage patterns and natural sedimentation processes. Long-term changes could occur where thermokarst erosion caused major changes in stream banks, and lake shorelines, and altered natural drainage patterns. Oil spills would have both short- and long-term impacts, especially to fish resources of Teshekpuk Lake and other fish-bearing lakes and streams.

Oil and gas exploration and development would result in both short-term and long-term effects to water quality. Construction activities associated with road and pad construction; culvert and bridge work in streams and lakes that disturbed stream banks or shorelines; blockages of natural channels and floodways that disrupted drainage patterns; and removal of gravel would all cause short-term increases in erosion and sedimentation. Water removal could cause short-term changes in aquatic habitat, although these impacts would be minimized by limiting water withdrawals to 15% of less of the total volume of the water body. Permanent gravel roads and pads, airstrips, pipelines, and facilities constructed adjacent to or crossing streams and lakes could have long-term effects on water quality. Oil spills would have both short- and long-term impacts on water quality, especially to fish resources of Teshekpuk Lake and other fish-bearing lakes and streams. The magnitude and duration of effects would vary with the type and extent of the activities.

Degradation of water quality from construction and operation of oil field(s), winter ice roads, and spills could have a long-term effect on isolated water bodies.

4.9.5 Vegetation

The effects of non-oil and gas activities on vegetation would be short term. However, the construction of well collars for exploration wells and the most severe impacts caused by vehicles during overland moves and seismic exploration would cause long-term affects on vegetation. All effects of oil-field construction on vegetation would be long term, though new oil spills and dust and gravel spray from vehicular traffic on the gravel pads would not occur after field

abandonment. The recovery time for vegetation from a spill could last several years (Jorgenson 1997, McKendrick 2000), but it is not known how long changes to plant communities as a result of dust effects would persist. Although research indicates that natural plant communities can be restored to gravel pads (McKendrick 1997), especially if some silt-loam soil is added to the substrate, the time until recovery of natural canopy cover would be so long that the impacts might be considered permanent from a human perspective. Therefore, the long-term productivity of these localized areas would be reduced; however, these areas represent between 0.1 and 1% of the planning area. Placement of gravel drilling pads, roads, airstrips, staging areas, and docks, as well as construction of pipelines or the use of gravel mine sites, would permanently disturb or destroy vegetation unless sites were reclaimed.

4.9.6 Wetlands and Floodplains

Biological resource areas that can be classified as having the function and value of wetlands and floodplains on the North Slope include vegetation, soils, and water resources. Please refer to the discussions for each of these resources for information on the relationship between local short-term uses and maintenance and enhancement of long-term productivity of wetlands and floodplains.

4.9.7 Fish

4.9.7.1 Freshwater and Anadromous/Amphidromous Fish

Impacts to fish resources and habitat would occur from oil and gas exploration and development. Most impacts would be short term and confined to small segments of habitat and localized components of the fish population. Although seismic surveys, construction activities, and oil spills are of particular concern, disturbances would be unlikely to result in decreased long-term productivity of fish populations. The exception would involve an oil spill in a waterbody with no migration pathways. Losses in a specific waterbody would be permanent if all individuals of a species were killed in a spill.

4.9.7.2 Marine Fish

Some marine fish could be lethally or sublethally affected by oil and gas activities in the planning area, but the number would likely be too small to be measurable at the population level. These effects are likely to be relatively short term, and with recovery expected within three years. It is possible that a very large spill (≥ 120,000 bbl) could affect the marine fish population in the immediate area, and this could require approximately 3 to 10 years for recovery, depending on the amount of oil reaching the nearshore area, and the amount of shoreline oiled.

4.9.8 Birds

Birds may experience short-term effects from any factors or activities that disturb their normal daily and seasonal pattern of activities. Of the routine activities associated with oil and gas exploration and development, helicopter, fixed-wing, and marine support vessel traffic would have the greatest potential for disturbing birds. Helicopter flights would likely occur throughout the life of this project. Although much of the potential effect of air traffic could be avoided through compliance with lease stipulations and ROPs, aircraft could be required to fly at lower altitudes and cross critical parts of the coast during inclement weather. Under these conditions,

disturbance of birds along the flight path could occur. Brant may be more affected by aircraft traffic, particularly helicopters, than other species (Derksen et al. 1992). Disturbances that affect survival rates of brant or other species of concern could have long-term effects on populations. The other sources of disturbance related to roads and facilities would result from vehicular traffic, heavy equipment use, routine maintenance activities, oil spill response training activities, and pedestrian traffic. These disturbances would likely impact birds during the life of the field, but would unlikely continue after field abandonment; the effects of habitat loss or alteration may continue indefinitely.

4.9.9 Mammals

4.9.9.1 Terrestrial Mammals

Most effects on terrestrial mammals and their habitats from non-oil and gas activities and from oil and gas exploration would be short term. Short-term, localized effects could occur in the event of an oil spill, although it is expected that oil spills in the planning area would be small and would not likely affect a large area. Potential effects include mortality of individuals, physiological stresses in surviving individuals, reduction in the number of species in the affected area, changes in the distribution of species or individuals, and changes in behavior or migration patterns. Long-term, cumulative effects could occur if recovery from the short-term effects extended beyond the production life of the field. The potential effects of noise disturbance and terrestrial habitat alteration could also include short-term, localized effects such as mortality, stress, decreases in or redistribution of populations or species, and changes in survival patterns. Effects of oil and gas development on terrestrial mammals and their habitats would be long term (beyond the production life of the field); however those effects are not expected to have impacts at the population level. Long-term biological productivity could be lost from areas used as facility sites.

4.9.9.2 Marine Mammals

Noise, disturbance, and habitat alteration from on-shore activities, shipping, and oil spills would temporarily affect some individual marine mammals and their habitats. These effects should be localized and short-term with the possible exception of a very large oil spill that reached marine waters (see **section 4.11**). Disturbances and altered habitat could result in local displacement, mortality, or stress in some species, or decreases or reductions in the local abundance of some species. Effects could possibly last over the long term if recovery from the short-term effects was extended beyond the field's estimated useful life.

4.9.10 Threatened and Endangered Species

Bowhead whales could be disturbed by noise from oil- and gas-related marine vessel traffic during years when the bowhead whale fall migratory path lies closer to shore than the mean migration distance (20 miles from 1982-2001; Treacy 2002a,b). Displacement would be temporary and short term, and could potentially occur annually over the life of the field. Aircraft traffic associated with development during the fall migration period potentially could disturb bowhead whales migrating very near shore. Since most of these activities are temporary, effects would be short term and potentially occur annually over the life of a field. In the unlikely event of a large oil spill, there could be long-term effects to the bowhead whale population from residual oil and continuing clean-up activities.

Spectacled and Steller's eiders could experience short-term effects from any factors that disturb their normal daily and seasonal pattern of activities and could continue for the life of the field. These disturbances would likely impact birds during the life of the field, but would be unlikely to continue after field abandonment. Aircraft and ground-based research activities could impact threatened eiders for the life of the field. Many of these activities would likely discontinue after field abandonment, although some aerial surveys, to conduct long-term monitoring, would most likely continue after abandonment.

The effects of eider habitat loss or modification adjacent to roads and pads would likely be short term, although loss of habitat due to gravel placement would have a long-term effect that would likely last beyond field abandonment, unless habitat restoration was planned and implemented. Although nesting or brood-rearing habitat loss in the footprint of gravel infrastructure would have a long-term effect, other suitable habitat is widespread, and the effect on threatened eider populations is expected to be minimal.

Potential eider mortality could result from collisions with vehicles or structures and would continue for the life of the field. Long-term effects could result if structures were not removed during field abandonment. However, eider mortality due to collisions with vehicles or structures has not been a major source of mortality in North Slope oil fields and would be unlikely to affect threatened eiders at the population level.

Short term disturbance of polar bears may result from winter exploration, construction and operation activities. It is possible that some polar bears could be killed in defense of life or property, but this is unlikely based on past practices. Un-restored abandoned pads and roads may provide conditions resulting in snow accumulation increasing available denning habitat. It is also possible that some areas of potential denning may have been lost as the result of gravel placement and would be permanently lost if the areas were not rehabilitated.

4.9.11 Cultural Resources

Because cultural resources are nonrenewable, there is no difference between short-term and long-term impacts. Cultural resources cannot endure most types of adverse effects. Historic structures could benefit from preservation and stabilization efforts prompted by nearby development. However, once disturbed, an archaeological deposit could never be returned to its original context. Any destruction of cultural resource sites could represent long-term losses. Salvage archaeology to recover remaining site data would generally result in the total destruction of the site, although the recovered data would, in most cases, effectively mitigate for loss of the site. Any discoveries of cultural resources made during surveys required prior to development of a lease would enhance knowledge of the history and early inhabitants of the region and serve to effectively mitigate further potential effects of activities in the area.

4.9.12 Subsistence

In the short term, the redistribution, reduction, or displacement of subsistence species could affect regional subsistence-harvest patterns. Such short-term effects would not be expected to have long-term consequences unless chronically imposed on the subsistence resource base of the region. Habitat destruction could cause a local reduction in subsistence species, a potential long-term impact to communities affected by such reductions. Increases in the amount of land used for infrastructure and development would reduce the amount of area suitable for subsistence hunting. Development along the coast could change the distribution of caribou in the summer, when the greatest numbers are harvested as the herds seek insect relief on beaches and in

shallow lake and marine waters. Roads would increase access and competition for resources over the long term and could further affect subsistence harvests. Increasing human populations would require that more resources be harvested over wider areas to maintain the subsistence way of life. The potential for user conflicts could increase in areas where current uses overlap.

4.9.13 Sociocultural Systems

Increased population, industrial activity, and minor gains in revenues and employment could potentially disrupt sociocultural patterns in Native communities in the short term. Income and employment allocation disparities could increase, causing intra-community conflict. Short-term effects on subsistence resources would disrupt social systems if these effects were to occur repeatedly (chronic) over the lifetime of oil and gas activities in the planning area and on the North Slope. Habitat destruction would locally reduce or displace subsistence species, a long-term cumulative effect on the regional subsistence economy. As a result, sociocultural values and cultural institutions would be affected. Activities or policies that act against the values of the Iñupiat residents of the region would increase social stress and concerns in the community.

4.9.14 Environmental Justice

Any impact on subsistence resources that would have a chronic effect on the sociocultural system or subsistence resources over the lifetime of oil and gas activities would disproportionately affect the Iñupiat people. Such an effect would only be expected to occur in the event of long-term population and productivity effects to caribou, fish, or water birds.

4.9.15 Coastal Zone Management

Land use could change along pipeline routes. If land use in parts of the planning area were to shift from subsistence-based activities to industrial activities, and if, after production ceased, use of the land reverted to subsistence, the effect would be short term. Long-term effects on land use could result if use of the infrastructure or facilities were to continue after the production life ended. Potential users could be other resource developers. Residents and nonresidents could become accustomed to the convenience of using existing facilities, such as roads.

4.9.16 Recreation Resources

Short-term use of portions of the planning area for oil and gas development could affect the long-term use and value of recreation and wilderness resources. Rehabilitation and removal of pads, roads, and facilities would be unable to restore the original condition of the land or its original recreation and wilderness value. If airstrips were not removed or rehabilitated, recreation opportunities in the area could be enhanced by increasing access. However, scenic quality, naturalness, and primitive and unconfined recreation opportunities, which are essential to wilderness values, still would be negatively impacted by the presence of the airstrip.

Oil and gas exploration, development, and production activities would constitute a short-term commitment of resources that could impact river values. For example, archeological and paleontological resources, which are nonrenewable, might be affected in the long term. The short-term commitment of resources would not affect the finding of nonsuitability on the Colville River, which is based on a combination of local political opposition and lack of Federal control of the right bank of the river.

4.9.17 Visual Resources

Short-term use of portions of the planning area for oil and gas development could affect the long-term value of visual resources. Rehabilitation, removal, and revegetation of pads, roads, and facilities would eventually cause the viewshed to resemble a more natural condition. However, it is possible that the full value of the original scenic quality and viewshed would not be regained. Visual resources could still be negatively impacted by any remnants of oil and gas activities and by changes to the original landscape particularly to line and form characteristics.

4.9.18 Economy

Economic benefits would accrue from production of oil and gas from Federal lands. Economic benefits, including any decrease in the Nation's dependency on foreign oil, would be short term. Increases in employment and associated personal income would occur over the life of the exploration, development, and operations activities. Revenue increases to the NSB and to the state and Federal governments would occur during the production years. However, these increases would occur only for the duration of the activities. Development activity would result in infrastructure that in the short term could enhance future productivity of oil and gas exploration, development, and production.

4.9.19 Public Health

In the case of public health, "long-term productivity" is defined as positive measures of health. The large-scale socio-economic changes possible over the lifetime of the project could result in substantial increases in social pathology in these communities. Because social pathology (such as alcohol and drug abuse and domestic violence) substantially impact the early childhood environment and through this pathway result in direct impacts to lifelong health measures as well as the chance of social dysfunction in subsequent generations, increases in social pathology would produce long-term commitment of resources. Similarly, if subsistence impacts materialize, the projected increases in diabetes and metabolic disorders would endure for the lifetime of affected individuals, without a direct relationship to termination of development. It is difficult to predict whether dietary changes resulting from decreasing success of subsistence hunting would result in a long-term or permanent dietary shift toward store-bought foods, or whether communities would revert to a subsistence-based diet as resources became more available. Increases in accidents would parallel social pathology as well as more difficult hunting conditions, and would endure until these problems had resolved. HIV and AIDS are chronic conditions: if an increased prevalence results from the proposed action, the problem would persist long after the conclusion of the project. Food insecurity and hunger would likely parallel the availability of subsistence resources, and may improve more rapidly if subsistence resources become more readily available at the conclusion of the project.

4.10 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Irreversible or irretrievable commitments of resources refers to impacts or losses to resources that cannot be reversed or recovered. Examples are the extinction of a species or the permanent conversion of a vegetated wetland to open water. In either case, the loss is permanent. The following section identifies irreversible and irretrievable commitments of resources that would occur if leasing occurred and resulted in oil and gas exploration, development, and production.

4.10.1 Air Quality

Air quality would be affected by well drilling, construction activities, and production. These effects would occur only during the life of the field(s). No irreversible or irretrievable effects on air quality would occur. Air quality would be affected by well drilling, construction activities, and production. These effects would occur only during the life of the field(s). There would be no irreversible or irretrievable effects on air quality.

4.10.2 Paleontological Resources

Because paleontological resources are nonrenewable, any impacts would render the resource disturbance irreversible and the integrity of the resource irretrievable.

4.10.3 Soil Resources

Soils covered by gravel pads, roads, landing strips, and other infrastructure facilities would be lost with respect to their value (such as a medium for the growth of vegetation) as soils. Rehabilitation of soils after field abandonment could allow soils to eventually re-establish. Soil in disturbed areas could re-establish over time, but soil development in cold climates is a very slow process. The desirable mitigation for soils would be to minimize the total area lost by minimizing the area of surface disturbance, best management practices, and use of shared facilities. Several of the lease stipulations and ROPs are designed to reduce the amount of soil impacted by exploration and development activities.

4.10.4 Water Resources

Thermokarst erosion along gravel roads and pads could result in changes to streambanks and lake shorelines, and altered natural drainage patterns that would last long after the life of the field(s). While there would be no irreversible or irretrievable effect on water resources, the restoration of the natural drainage could take years after the field(s) were abandoned, equipment removed, and the roads and pads rehabilitated.

Thermokarst erosion along gravel roads and pads could result in degraded water quality that would last long after the life of the field(s), but the effects would not be irreversible. Oil spills could have an irretrievable effect on water quality if the spill could not be cleaned up and the oil sank to the bottom of the lake or contaminated the shoreline to the level that cleanup was not practical.

4.10.5 Vegetation

Permafrost-related geomorphic processes occurring on the ACP create a constantly changing landscape that influences successional patterns in plant communities. Most plant communities of Alaska's North Slope are well adapted to these frequent changes (Billings and Peterson 1980; Bliss 2000; Funk et al. 2004). Therefore, changes in plant communities resulting from dust or snowdrift accumulations or the formation and draining of impoundments would not be considered irreversible. However, the burial of vegetation under gravel fill could be considered an irretrievable commitment of vegetation resources, as the potential recovery of vegetation on these pads could take 25 to 30 years or more (McKendrick 1997, 2000).

4.10.6 Wetland and Floodplains

Biological resource areas that can be classified as having the function and value of wetlands and floodplains on the ANS include vegetation, soils, and water resources. Please refer to the discussions for each of these resources for information on irreversible and irretrievable commitment of resources in relation to wetlands and floodplains.

4.10.7 Fish

4.10.7.1 Freshwater and Anadromous/Amphidromous Fish

Arctic fish in and near the planning area would be exposed to overland seismic surveys, construction-related activities, and spills associated with oil and gas exploration and development. A relatively small number of fish would likely be affected by these activities. Fish populations should not experience any irreversible and irretrievable effects associated with activities undertaken as a result of this supplement.

4.10.7.2 Marine Fish

While some marine fish could be lethally or sublethally affected by management actions in the planning area, it is unlikely that these effects would be biologically measurable at the population level. The exception would be a hypothetical 120,000-bbl oil spill. It is possible that a very large spill (≥ 120,000 bbl) could affect the marine fish population in the immediate area, and this could require approximately 3 to 10 years for recovery. Because full recovery would be expected following any oil spill, no irreversible and irretrievable commitment of resources should occur.

4.10.8 Birds

Some irretrievable and irreversible loss of habitat would occur from the placement of gravel for infrastructure in bird nesting or brood-rearing habitats. Loss of wetland habitat used by waterfowl and shorebirds could be particularly important. In most scenarios, alternate habitats would likely be available and any habitat loss would have a minor effect. Loss of individual birds through collision with facilities or structures could occur; however, such losses are not expected to have an effect at the population level.

4.10.9 Mammals

4.10.9.1 Terrestrial Mammals

It is possible that caribou and other terrestrial mammals could be subjected to the direct and indirect effects of noise and movement of motor vehicles and aircraft, other human activities, oil spills, natural gas blowouts, or losses and deterioration of habitat because of facility developments. It is likely that such effects would lead to some permanent (irreversible) losses of these resources.

4.10.9.2 Marine Mammals

Seals, walruses, gray whales, and beluga whales could be subjected to direct and indirect effects of oil spills, disturbance caused by noise and movement of aircraft and vessels, and other human activities. It is unlikely that such effects would lead to permanent (irreversible) losses of these resources.

4.10.10 Threatened and Endangered Species

For threatened and endangered species, any irretrievable or irreversible commitment of resources important to the long-term survival and recovery of the species would probably violate the intent of the Endangered Species Act. Since the bowhead whale population is increasing and effects from noise would likely be temporary, irreversible or irretrievable losses would be unlikely. It is possible that collisions could result in the killing or severe injury of bowhead whales, but these events are likely rare and unlikely to impact the population. Any deterioration of the bowhead whale auditory environment resulting from noise-producing activities in coastal areas would last only as long as the causative activity. No irretrievable/irreversible loss of bowhead whale habitat is expected.

Some irretrievable and irreversible loss of habitat could occur from placement of gravel infrastructure for oil and gas facilities in spectacled or Steller's eider nesting or brood-rearing habitat. This loss of habitat could be permanent unless habitat restoration was planned and successfully implemented during field abandonment. Impoundment formation adjacent to roads and pads could also create habitat for threatened eiders. Because alternate habitat would likely be available in areas adjacent to proposed development, any habitat loss would likely have a minor effect on threatened eiders.

Eider mortality could result from collisions with vehicles or structures during the life of the field. Any losses of individual eiders through collision with facilities or structure would be irretrievable, but would not be expected to affect eiders at the population level. If structures were not removed, long-term effects to eiders could result after field abandonment.

Irretrievable loss of polar bears may occur from DLP taking; however, as noted previously this is expected to be an unlikely and rare event. Some denning habitat may be permanently altered as the result of development; however, the amount affected would be unlikely to influence populations.

4.10.11 Cultural Resources

Cultural resources are nonrenewable, so any impacts would be irreversible, and the integrity of the affected resource would be irretrievable. Since most known cultural resources exist in a surface or near-surface context, burial by the construction of a gravel pad or road, while possibly not damaging in itself, would affect the cultural resource upon removal of the gravel. If subsurface cultural resources were encountered, as during the development of a gravel mine site, such resources could be damaged or destroyed. The loss of such cultural resource information would be irreversible and irretrievable. Salvage archaeology to recover remaining site data would generally result in the total destruction of the site, although the recovered data would, in most cases, effectively mitigate for loss of the site. Any discovery of cultural resource data as a result of surveys required prior to development of a lease would enhance long-term knowledge. Overall, such finds could help fill gaps in our knowledge of the history and early inhabitants of the area.

4.10.12 Subsistence

Many important aspects of Iñupiat society and culture are centered on subsistence activities. Virtually every family in North Slope coastal communities participates in the hunting of the bowhead whale and the sharing of its meat and maktak. The activities associated with harvest of caribou, fish, birds, wolf, wolverine, and seals are only slightly less important to the cultural integration of the region as a whole, but they are of equal importance to the inter- and intra-community social organization, cultural identity, and the domestic economies of most households. The reduction or loss of the ability to harvest sufficient quantities of these resources would be an irreversible and irretrievable loss to the Iñupiat diet, to Iñupiat traditional practices of sharing and reciprocity, and to fundamental aspects of Iñupiat identity. If subsistence users were to abandon traditionally used harvest areas because of legal or perceived regulatory boundaries or contamination concerns at or near an oil or gas development, this abandonment would contribute to a loss of access, affecting the connection of Iñupiat subsistence users to traditional use areas.

4.10.13 Sociocultural Systems

Disruption of the traditional harvest of bowhead whales and caribou could constitute an irreversible and irretrievable loss to Iñupiat social and cultural values. The alienation of Iñupiat subsistence users from their homelands would be an irreversible and irretrievable commitment of resources, as land use patterns have shown that when oil and gas development activities take place in an area, other land uses are curtailed and land users excluded (Brown 1979; Pedersen et al. 2000). This connection to the land is one factor that constitutes Iñupiat identity, not least in terms of how one identifies oneself in Iñupiat society by area of residence, such as Kuukpikmiut, a person of the Colville River area. The contribution of oil and gas development in the planning area to the cumulative consequences of offshore and onshore energy development could, in conjunction with other processes of social change in the long term, lead to social and cultural conflicts within and between communities and contribute to the compromise of Iñupiat value systems. If the Iñupiat were to lose access to traditional use areas and culturally-valued sites in the planning area, or avoid them for cultural reasons, then sociocultural patterns could be affected; there would be a loss of continuity between generations and changes in sharing and reciprocity within and between communities as a result of a reduction in subsistence harvests.

4.10.14 Environmental Justice

Long-term population and productivity effects to caribou herds, fish populations, or waterfowl from oil and gas development could produce irreversible and irretrievable effects to subsistence resources. These effects would translate into effects on Native minority populations and thus raise environmental justice issues.

4.10.15 Coastal Zone Management

There are no anticipated conflicts with the statewide standards of the Alaska Coastal Management Program or the enforceable policies of the NSB Coastal Management Program. Development activity would result in the construction of infrastructure, but the majority of the infrastructure would be inside the boundaries of the planning area. Some infrastructure, such as pipelines, could be located outside the planning area, within the boundaries of the NSB, but such infrastructure could be removed after development ended.

4.10.16 Recreation Resources

There would be no irreversible and irretrievable commitment of recreation resources. Proper rehabilitation and removal of development pads and other structures would restore the perception of a natural environment. Wilderness values would be forgone in those areas affected by development for the duration of the development, rehabilitation, and recovery. The degree of impacts to wilderness values would depend on the level of success of rehabilitation and recovery efforts after completion of petroleum production.

Irreversible and irretrievable impacts on Wild and Scenic River values on the Colville River are possible as a result of oil and gas exploration, development, and production activities, but the effects would likely be limited to a relatively small area near a pipeline or road crossing. The potential effects would not alter the finding of nonsuitability for the Colville River.

4.10.17 Visual Resources

There would be no irreversible or irretrievable commitment of visual resources. Proper removal, rehabilitation, and revegetation of development pads and other facilities would restore the perception of a natural environment. To the casual observer, viewsheds would appear natural.

4.10.18 Economy

Increases in employment and personal income would occur over the life of the exploration, development, and operation activities. Investment by the lessees and operators in oil and gas exploration and development activities in the planning area would represent a loss of opportunity to invest those monies elsewhere. Revenue increases to the NSB and the state and Federal governments that would occur during production years would result in the irreversible and irretrievable commitment of those revenues. Development would result in new infrastructure that would be removed at the end of production.

4.10.19 Public Health

In the case of public health, any enduring change in community health status, or any chronic or fatal illness in an individual, constitutes an irreversible or irretrievable commitment of

resources. Increases in chronic disease prevalence which may occur as a result of the proposed action include increases in diabetes and related metabolic disorders, increases in cardiovascular and cerebrovascular diseases, and, if contaminants from oil and gas development enter the food chain at substantial levels, increases in cancer, endocrine disorders, and neurodevelopmental delay. Long-term, community-wide increases in social pathology might result from the alienation of subsistence uses from their homelands and traditional subsistence way of life. At an individual level, mortality from chronic metabolic disorders, cancer, suicide, infectious diseases, exacerbations of chronic respiratory disease, violence, and unintentional injury, to the extent that the proposed action may contribute to increases in these problems, would constitute an irreversible and irretrievable commitment of resources.

4.10.20 Oil and Gas Resources

Oil and gas resources are expected to be leased, discovered, developed, and produced as a result of leasing in the planning area. The oil and gas resource estimates for each alternative considered in this amendment are presented in Table 4.2-D. For the highest case scenario (Alternative C), it is estimated that approximately 4,050 MMbbl oil would be available for production. Should these resources be produced, they would be irretrievably consumed. In the unlikely event of a large oil spill, the oil spilled would be irretrievably lost.

4.11 LOW-PROBABILITY, VERY LARGE OIL SPILL

4.11.1 Introduction

This section discusses the probabilities and potential effects of a very large oil spill in the planning area. In this Supplemental IAP/EIS, a very large spill is defined as greater than or equal to 120,000 bbl of oil. A very large oil spill is a low-probability event with the potential for severe effects. A similar analysis of a very large tanker or pipeline spill was included in Appendix B of the 1998 Northeast IAP/EIS (USDOI BLM and MMS 1998) and is incorporated here by reference. Various scenarios for large pipeline spills were analyzed in the Final EIS for the TAPS pipeline (USDOI BLM 2002a). Because very large spills happen so infrequently, there is limited historical data for use in statistical analysis and prediction.

The ADEC North Slope spill database for 1995 to 2003 (ADEC 2003) indicates that five very large volume spills have been reported for the North Slope oil fields since 1977, none of which were of oil or produced fluids. During that time the total oil production was approximately 1.6 x 10^{12} gallons (ADR 2004a). Thus, the probability of a very large volume oil spill occurring in the Planning Area is extremely low.

The largest hypothetical spills would be of produced fluids from a well blowout. However, the largest spills in the ADEC 1995 to 2003 database are of seawater and produced water. The following very large volume spill impact assessment is based primarily on potential spills of produced fluids from a blowout.

4.11.1.1 Well Control Incidents

The record of Alaska North Slope well control incidents or blowouts is not validated, but is presented as the best available information. Although the State of Alaska does not maintain a database of North Slope well-control incidents, the Alaska Oil and Gas Conservation Commission maintains an internal documentation of blowouts in Alaska. Neither of the authors cited below (Mallory 1998; Fairweather E&P Services, Inc. 2000) was allowed to review the documentation. The Alaska Oil and Gas Conservation Commission assured Fairweather E&P Services, Inc., that no blowouts had been overlooked.

Two written reports regarding blowouts on the Alaska North Slope are available—Mallory (1998) and Fairweather E&P Services, Inc. (2000). Mallory (1998) presents the following data based on discussions with long-time Alaska drilling personnel with ARCO Alaska or BP Exploration Alaska (BPXA). In the period 1974 through 1997, an estimated 3,336 wells were drilled on Alaska's North Slope. Research conducted to date has documented six cases where secondary well control was lost with a drilling rig on the well. The documentation does not differentiate between exploration and development wells. No oil spills, fires, or loss of life occurred in any of the events (Mallory 1998).

Fairweather E&P Services, Inc. (2000) differentiated between a blowout and a well-control incident. A blowout was defined as an uncontrolled flow at the surface of liquids and/or gas from the wellbore that resulted from human error and/or equipment failure. Fairweather E&P Services, Inc. (2000) found 10 blowouts: the 6 blowouts that Mallory had identified and 4 blowouts that occurred before 1974. Of the 10 blowouts, 9 were gas and 1 was oil. The blowout of

oil in 1950 was unspectacular and could not have been avoided, since there were no casings or blowout preventers available (Fairweather E&P Services, Inc. 2000). These particular drilling practices from 1950 would not be relevant today.

A third study confirmed that no crude-oil spills greater than or equal to 100 barrels occurred from blowouts between 1985 and 1999 (Hart Crowser, Inc. 2000). The record of oil spills less than 100 bbl from blowouts was not searched by Hart Crowser, Inc. (2000).

Two spills of volumes greater than 50,000 bbl from blowouts have occurred in Federal waters since offshore drilling began in the U.S. The largest spill from a blowout in federal waters was 80,000 bbl from the blowout in Santa Barbara Channel in 1969; the other was in the Gulf of Mexico in 1970. Because there have been no spills greater than or equal to 120,000 bbl in U.S. waters from blowouts, worldwide historical spill data must be incorporated to estimate the chance of a very large spill occurring. The information used here is based on spills from countries that do not have the regulatory standards that are enforced on the OCS or BLM-administered lands. In addition, some drilling practices used elsewhere either are not practiced here or are against MMS and BLM-administered regulations.

From 1979 through 2000, five oil-well blowouts greater than or equal to 10 million gallons (238,000 barrels) have occurred worldwide (Oil Spill Intelligence Report 1996; Cutter Information Corp. 1997; DeCola 2001). The causes of the blowouts were either war or drilling practices that oil companies do not now use and are not allowed to use under MMS regulations in the U.S. During this same time period, there were roughly 471 billion barrels of oil produced worldwide (British Petroleum 2001). These data indicate that the rate of occurrence of blowouts greater than or equal to 10 million gallons is 0.01 blowouts per billion barrels produced. If this rate is applied to Alternative C for the planning area, the estimated probability of one or more oil spills of 10 million gallons (238,000 barrels) is 0.042 over the lifetime of the development that could occur under that alternative.

S.L. Ross Environmental Research Ltd. (1998) calculated the chance of an extremely large oil spill (greater than 150,000 bbl) from a blowout with an average number of wells from the Northstar and Liberty projects using worldwide spill frequencies would be similar to those presented in the preceding paragraph.

Scandpower AS (2001) completed a blowout-frequency assessment for the Northstar development project. This analysis modified statistical blowout frequencies to reflect specific conditions and operating systems for drilling at Northstar. The estimated blowout frequency for drilling into the oil-bearing zone and spilling greater than 130,000 bbl is 9.4×10^7.

At North Star, the State of Alaska prohibits the drilling of new wells or sidetracks from existing wells into major liquid-hydrocarbon zones at drill sites under their regulation during the defined period of broken ice and open water. This period begins on June 13 of each year and ends when 18 inches of continuous ice cover are present for a half mile in all directions from the Northstar Island. This seasonal drilling restriction eliminates the environmental effects associated with a well blowout during drilling operations in broken ice or open-water conditions.

Although the drilling prohibition reduces the chance of a blowout during periods of broken ice and open water, the chance of a blowout occurring during these periods is not completely eliminated when oil is being produced.

As noted in the following section, the State of Alaska requires as a planning standard the greatest possible oil spill discharge that could occur from a blowout. Thus, this amendment evaluates the potential effects of a very large oil spill.

4.11.2 Blowout Assumptions

As described in Alaska Clean Seas Technical Manual, Volume 1 (Alaska Clean Seas 1999), the North Slope Spill Response Project Team (a joint industry-agency task force) specified that for oil spill planning purposes, flow rates to be used for wells in areas without adequate production history data (e.g., planning area) are estimated at 5,500 bbl/day. The North Slope Spill Response Project Team also specifies that for planning purposes, a 15-day blowout is to be assumed. In the Oil Discharge Prevention and Contingency Plan for the Alpine field, ConocoPhillips estimates a 7,500-bbl day flow rate for 15 days, for a total of 112,500 bbl. In this analysis, the 7,500 bbl/day flow rate is used, rounded up to 8,000 bbl/day for a total of 120,000 bbl for the 15-day period.

The potential impacts on specific resources are presented below. In each resource-specific analysis, the blowout hypothetically occurs in an area sensitive to that particular resource and releases crude oil into the environment for 15 days. For the scenario, the analyst places the blowout spill in the location most susceptible to the resource. The general environments into which the oil could discharge are tundra, ponds, lakes, creeks, rivers, and lagoons. The blowout could occur at any time of the year. The receiving environment could be solid ice, broken ice, or open water, as well as snow and open ground.

The following blowout assumptions are taken from oil discharge prevention and contingency plans from facilities on the Alaskan North Slope (PAI 2001; BP Exploration (Alaska), Inc. 2000, 2001a,b).

- The crude oil is assumed to be similar in composition to “Alpine field” crude oil.
- The theoretical facility is a 5-acre gravel pad.
- The gas/oil ratio ranges from 400 to 2,200 standard ft3/bbl.
- The blowout spill rises into the air at an average rate of 300 bbl/hour (8,000 bbl/day divided by 24 hours).
- Oil droplets fall to the gravel pad and surrounding area in the direction of the prevailing wind.
- Assuming an Alpine field-like crude oil, approximately 30% of the 120,000 bbl evaporates into the air, leaving 84,000 bbl on or adjacent to the gravel pad and surrounding area.

The following figures are based on Alaska Clean Seas (1999) Tactic T-6, assuming a 6.3-inch pipe and the lowest and highest gas/oil ratios. The highest gas/oil ratio results in the higher values below. Of the oil falling to the surrounding environment:

- Eighty percent of the oil falls out from 300 feet (lowest gas/oil ratio) to 3,600 feet (highest gas/oil ratio) from the source, in a plume 100 feet (lowest gas/oil ratio) to 400 feet (highest gas/oil ratio) wide; and
- Twenty percent of the oil falls out from 3,600 feet (lowest gas/oil ratio) to 33,000 feet (highest gas/oil ratio) from the source, in a plume 400 feet (lowest gas/oil ratio) to 2,000 feet (highest gas/oil ratio) wide.

After 15 days from the start of the spill:

- 3,400 bbl remain on the gravel pad;
- 38,600 bbl have drained from the gravel pad into the environment; and
- 42,000 bbl have fallen to the surrounding environment (2,800 bbl/day).

4.11.3 Behavior and Fate of a Blowout Oil Spill During Various Seasons

During a blowout, oil would fall to the pad and surrounding area in a scattered pattern. Some of the oil falling to the pad would drain to the surrounding area. How the oil would behave after that would be dependent upon the season.

4.11.3.1 Winter

For a spill occurring during winter, oil would spread mainly on the surface of snow cover, ice, and/or frozen soil. No oil would enter open water as long as the ice remained solid. There would be little or no change in the oil's physical properties at very low temperatures and when buried under a snow cover. Blowing snow would tend to combine with pooled oil until the oil was effectively saturated with snow crystals.

The oil would not penetrate any ice surface. It would spread mainly on the surface of the frozen soil. It is unlikely to penetrate the lower layers of soil because the seasonal thawed layer would be absent (Chuvilin et al. 2001).

4.11.3.2 Fall Freezeup

Broken ice occurs in the planning area during fall freezeup and spring breakup. The scenario for this analysis assumes that oil would fall to the broken ice in a scattered pattern and would drain from the pad into broken ice in tundra ponds, lakes, streams, rivers, or lagoons. The ice would contain the oil somewhat and reduce spreading. Unless the oil was frozen into the ice, the evaporation rate would not change. Dispersion and emulsification rates would be lower in broken ice than in open water.

For a spill occurring during fall freezeup, the oil would freeze into the ice and slush before ice sheeting occurred. Winds and storms could break up and disperse the ice and oil until the next freezing cycle. These freezing cycles can be hours or days. In late spring and summer, this unweathered oil would melt out of the ice at different rates, depending on when the oil was frozen into the ice. In first-year ice, most of the oil spilled at any one time would percolate up to the ice surface over about a 10-day period. About mid-July, the oil pools would drain into the water. Thus, oil could be pooled on the ice surface for up to 30 days before being discharged from the ice surface to the water surface. The pools on the ice surface would concentrate the oil, but only to about 2 mm thick, allowing evaporation of approximately 5% of the oil–the part of the oil composed of the lighter, more toxic components of the crude. By the time the oil was released from the melt pools on the ice surface, evaporation would have almost stopped, with only an additional 4% of the spilled oil evaporating during an additional 30 days on the surface of the pond, lake, creek, stream, or river.

4.11.3.3 Spring Breakup

For analysis, it is assumed that a spill occurring during spring breakup would have the same behavior and effects as a summer or open-water spill. At spring breakup, the ice concentrations are variable. With high concentrations of ice, oil would spread between ice floes. As the ice concentrations eventually decreased to less than three-tenths of the water surface area, the oil on the water would behave as an open-water spill, with local oil patches temporarily trapped by the wind against ice floes. Oil on the ice floes would move with the ice as it responded to currents generated by the wind (S.L. Ross Environmental Research Ltd. 1998).

4.11.3.4 Summer

This scenario assumes that oil would drain from the gravel pad onto the tundra and/or open water, including lakes, ponds, creeks, streams, rivers, or lagoons. If oil were to fall on a water surface, the oil would move with the direction of flow and/or the winds. On the tundra, during the summer, the oil would spread less because of the cover of vegetation. Oil could penetrate the lower layers of soil because of their thawed condition. Rain could also increase the penetration of oil into the soil. The oil could spread laterally if it reached a permafrost lens or layer (Chuvilin et al. 2001).

4.11.4 Effects of a Low-Probability, Very Large Oil Spill

4.11.4.1 Air Quality

A very large (≥ 120,000 bbl) oil spill would affect air quality locally and temporarily. Air quality impacts would occur from evaporation (VOC) and burning (CO, NOx, and some PM) associated with the oil spill or with oil-spill clean-up activities. The scenario for a low probability, very large oil spill assumes that the release of crude oil would continue for 15 days. Therefore, VOCs would continue to be released from the spilled oil for that length of time. The VOC concentrations are anticipated to be low, would normally be limited to an area close to the spill, and would evaporate completely soon after the spilling ceased. The use of burning to mitigate spilled oil would nearly eliminate VOC emissions, but would create CO, NOx, and possibly SO_2 impacts. Winds would encourage evaporation, and further disperse the VOC or combustion concentrations. Therefore, air quality effects from a very large oil spill should remain localized and temporary.

4.11.4.2 Paleontological Resources

Impacts to surface and near-surface paleontological deposits would likely be greater for a summertime spill than for one that occurred during the winter. While contamination of the deposit could render much of the data recovery valueless, the clean-up procedures would create even greater impacts. Since paleontological resources are nonrenewable, the effects could be substantial.

4.11.4.3 Soil Resources

Spills can create direct toxic effects to soil productivity, and depending on the season, soils can also be impacted by compaction and thermokarst during cleanup activities. There is no history of the effects of a very large spill of crude oil on North Slope soils. Overall, past spills (of much smaller volumes) on Alaska's North Slope have caused minor ecological damage, and ecosystems

have shown good potential for recovery, with wetter areas recovering more quickly (Jorgenson 1997, McKendrick 2000, NRC 2003). It is estimated that a spill of 120,000 bbl would cover up to 1,500 acres, with 80% of the oil falling out on less than 30 acres. Oil spills of any size could impact soils by altering vegetation. From these numbers it is assumed that most of the vegetation affected would be impacted. The oil alone would decrease plant growth, but oil spills probably would leave the surface organic mat intact. Spill cleanup, however, would be more likely to damage soils. Cleanups are not always well controlled; heavy traffic and digging are common and can result in damaged soils. Cleanup of oil spills would mitigate impacts to soils only if the clean-up methods and operations were very carefully controlled to minimize surface disturbance.

4.11.4.4 Water Resources

A very large crude-oil spill could have serious impacts to streams and lakes. While the petroleum residue from a spill could be flushed from most streams within a few years, the impacts to lakes and ponds could persist for decades. Additionally, a very large spill could saturate the tundra mat with oil, limiting the amount of crude oil that was recovered, and considerably lengthening the time over which impacts could occur. A spill that occurred in the winter could have similar impacts, although the snow and cold temperatures might retard the crude-oil runoff into the watershed and somewhat limit the contamination. A spill that occurred during spring breakup or fall freeze-up could have the greatest impacts, since it would be extremely difficult, if not impossible, to contain the spill when ice was either breaking apart or forming into semi-solid slush pans or jumble ice. Spill cleanup in the watershed would involve containing the spill, diverting or isolating it within the water body, skimming off the oil, and treating the remaining oil-contaminated water and sediments. Prevention and rapid response with adequate removal equipment would minimize effects.

For spills during frozen conditions, it is anticipated that oil would not reach open water. Following contaminated snow and ice removal, water quality impacts from the residual oil would be very limited in extent. However, even small quantities of oil remaining after cleanup could result in lethal and sublethal toxicity levels in waters within the spill area for approximately seven years.

During summer, flat coastal tundra develops a dead-storage capacity averaging 0.5 to 2.3 inches (Miller et al. 1980) that would retain 300 to 1,500 bbl of oil per acre. Even at high water levels, the tundra vegetation tends to act as a boom and vegetation and peat as a sorbent, allowing water to filter through, trapping the more viscous oil (Barsdate et al. 1980) and also making recovery of the oil more difficult. On the other hand, even small spills can spread over large areas, if the spill event includes aerial, pressured discharge. For example, in December 1993, an ARCO Drill Site line failed and 1 to 4 bbl of crude oil misted over an estimated 100 to 145 acres (Ott 1997). For a large spill during breakup conditions or the summer season, oil-spill response likely would recover the bulk of spilled oil. However, sufficient oil could remain to result in lethal and sublethal toxicity levels in waters within the spill area for approximately 7 years. In addition, equipment used to contain and recover spilled oil could damage the tundra surface, potentially leading to thermokarst erosion and causing local water quality degradation.

4.11.4.5 Vegetation

The only reported blowout of crude oil on Alaska's North Slope occurred in 1950 (Fairweather E&P Services, Inc. 2000), and no crude oil was spilled off the pad during that blowout. There is no history of the effects of a very large spill of crude oil on North Slope tundra vegetation.

Overall, past spills (of much smaller volumes) on Alaska's North Slope have caused minor ecological damage, and ecosystems have shown good potential for recovery, with wetter areas recovering more quickly (Jorgenson 1997, McKendrick 2000, NRC 2003). It is estimated that a spill of 120,000 bbl would cover up to 1,500 acres, with 80% of the oil falling out on less than 30 acres. From these numbers it is assumed that most of the vegetation affected would be impacted. A percentage of the vegetation affected would likely suffer longer-term consequences, suggesting that recovery would take longer and might not be as complete.

4.11.4.6 Wetlands and Floodplains

Biological resource areas that can be classified as having the function and value of wetlands and floodplains on the North Slope include vegetation soils, and water resources. Please refer to the discussions for each of these resources for information on the potential impacts of a very large spill.

4.11.4.7 Fish

Anadromous/Amphidromous Fish

As discussed in the analyses for the alternatives, oil spills have been observed to have a range of effects on fish; the specific effect depends on the concentration of petroleum present, the length of exposure, and the stage of fish development involved (eggs, larva, and juveniles are most sensitive; Malins 1977; Hamilton et al. 1979; Starr et al. 1981). If lethal concentrations were encountered, or if sublethal concentrations were encountered over a long enough period, fish mortality would be likely. Such a situation could occur during a large blowout spill if the spill were to enter a body of water with restricted water exchange. The worst-case scenario would be a spill that occurred at fall freezeup or at the beginning of spring breakup in the lower reach of one of the large rivers that flows into Harrison Bay. Cleanup of a spill when ice was either forming into slush pans or breaking apart would be difficult. Petroleum residue would persist through the winter (and beyond) if the spill occurred at freezeup. Compounding this problem is the likelihood that freshwater fish of all life stages would be congregating in this habitat to overwinter. Craig (1989a) calculated that the lower portion of coastal plains rivers on the North Slope provide most of the overwintering habitat for freshwater fish.

Though lethal effects of oil on fish have been established in laboratory studies (Moles et al. 1979; Rice et al. 1979), large kills following oil spills are not well documented, probably because toxic concentrations are seldom reached (Rice 1985). In this scenario, where it is assumed that a large quantity of oil reaches numerous fish and the oil is not rapidly diluted, a substantial portion of the water body's resident populations of fish species could be harmed or killed. Adults and juveniles might be able to avoid contact with oiled waters during a spill in the open-water season, but survival would be expected to decrease if oil were to reach a pool or series of pools isolated by ice and the fish were unable to avoid contamination. In the latter case, sublethal effects would be more likely to occur, and would include changes in growth, feeding, fecundity, and survival rates, and temporary displacement. Other possible effects would include localized reduction in food resources, and consumption of contaminated prey. Total fish loss would be dependent on the extent and duration of the contamination and the effectiveness of the spill cleanup. If the entire population of any given species in a drainage were spread out among overwintering sites in a river or adjacent lakes, the loss at any given site would not be expected to eliminate a population.

Marine Fish

A very large nearshore spill during the summer feeding period would likely result in moderate to high effects on some marine fish populations. It is possible that a very large spill (≥ 120,000 bbl) could affect the marine fish population in the immediate area. Both lethal and sublethal effects would be expected. Fishes farther offshore of the nearshore feeding area would likely not be affected. The occurrence of a very large spill during winter could have similar effects when released from the ice during the following spring. In either case, recovery would be likely in 5 to 10 years. If such a spill were to occur well offshore in summer, much of its effect would be reduced by weathering and the resulting reduction in the amount of oil reaching nearshore feeding areas. While the spill would still be expected to result in a moderate to high effect on some marine fish populations, its effect would likely be greatly reduced (estimated recovery of 3 to 5 years).

4.11.4.8 Birds

Effects of a Blowout Oil Spill on Birds

Throughout the summer and fall periods, many tens of thousands of long-tailed ducks, other waterfowl, loons, shorebirds and seabirds are present for varying intervals in coastal lagoons and nearshore and offshore waters of the Beaufort Sea. Although larger concentrations occur in areas east and west of the planning area than in areas near shore and offshore of the planning area (Johnson et al. 1993; Fischer et al. 2002; Ritchie et al. 2002) there are large numbers of birds in near shore and offshore waters of the planning area during the spring and fall staging and molting periods. If a 120,000-barrel offshore spill were to occur in the planning area, when large concentrations of molting, staging, or migrating birds were present, thousands of birds could be contacted by oil, potentially resulting in a substantial loss of birds. A spill that spreads out of the planning area to adjacent coastal or offshore areas could impact a larger number of birds and could impact several thousand nesting or postbreeding common eiders concentrated near barrier islands and in coastal lagoons. Other species likely to be affected by a large oil spill include scoters, northern pintail, Pacific loon, phalaropes, and glaucous gull. Red-throated and yellow-billed loons, whose ACP populations are relatively small, also could be affected. Large numbers of molting and staging geese and shorebirds could be affected in coastal areas of the planning area.

A large spill occurring in August or September, and affecting a substantial proportion of the thousands of Ross's gulls that gather east of Point Barrow to feed each fall (Divoky et al. 1988), could result in a substantial loss of this species, whose world population most likely does not exceed 50,000.

A terrestrial spill from a pipeline during the breeding, molting or staging periods may enter lakes and streams used by waterfowl and shorebirds and could adversily affect nesting, foraging, brood-rearing and molting habitat. Oil from the feathers of incubating adults may cover eggs, reducing oxygen transfer through the shell and causing embryo mortality. Direct mortality to adult birds could occur through hypothermia after contact with oil or by ingestion of oil. A spill in the Goose Molting Area during the period of time when large numbers of brant are molting could cause a population level effect to brant populations as many as 30% of the Pacific Flyway population of brant may be present in the area at one time.

Blowout During Open-Water Conditions

Although spill containment, recovery, and clean-up techniques under ideal weather conditions may be effective, these conditions may not exist during a spill incident and some loon, waterfowl, shorebird, and seabird habitats are likely to be contacted by oil. Individuals or groups of birds are widespread in their offshore distribution, ranging from the shoreline to 30 miles or more offshore. If a large spill is not contained before reaching areas of bird concentrations, hazing tactics may help to reduce the number of birds that may be affected by the spill.

Containment, recovery, and clean-up activities for a large spill are expected to involve hundreds of workers and numerous boats, aircraft, and onshore vehicles operating over an extensive area for more than one year. Persistence of oil in the environment would vary depending on weather conditions and speed of containment, recovery, and cleanup. The presence of such a workforce is likely to produce hazing effects, by displacing birds from the immediate area of the spill. If a reliable system of locating bird concentrations in a specific area can be devised, specific birds or groups in danger of oil contact could be targeted with specific hazing tactics.

Displacement of female waterfowl with broods from coastal habitats by clean-up activity may have a negative effect if it prematurely forces them into the offshore marine environment where foraging may be more difficult for the ducklings. Disturbance of nesting sea ducks by onshore clean-up activities is not expected to have a major impact on their productivity unless disturbance happens in an area of concentrated nesting effort or to individuals with low and/or declining populations. Because of low nesting density of ducks along the coast, few nesting birds are likely to be displaced and potentially lose their clutches or broods to predators or exposure to weather as a result of disturbance by clean-up operations. Helicopter support traffic, human presence, and short and long term habitat disturbance probably would be the most disturbing factors associated with oil spill clean-up activity.

Prompt containment and removal of oil from offshore areas, accompanied by hazing tactics targeting high-use areas, would likely to result in a substantial reduction of loon, waterfowl, and shorebird mortality from a large oil spill. Cleanup also would decrease the amount of oil available for uptake by bottom-dwelling organisms that are the principal food of sea ducks and shorebirds.

A 120,000-barrel oil spill in offshore waters of the Beaufort Sea could result in the loss of thousands of waterfowl and shorebirds utilizing habitats either in offshore areas or along the shoreline. Oil from an offshore spill that spread to areas adjacent to the planning area could impact more birds in those adjacent areas than in the planning area.

Blowout During Broken-Ice Conditions

Containment and oil recovery following a blowout spill that enters the marine environment under broken-ice conditions at meltout or freezeup is expected to be less effective than for an open-water spill. Under these conditions the spill would be contained in a smaller area than a spill in open water, and fewer birds are likely to occupy broken ice unless areas of open water are available. However, Pacific loons, long-tailed ducks, king eiders, common eiders, and glaucous gulls have been observed in small areas of open water available under these conditions (Dau and Hodges 2003). Even after spring melting provides areas of open water, most arriving spring migrants likely would occupy overflow areas off river mouths, because those are available earlier and are in the vicinity of nesting areas. The hazing effect of clean-up activity or

actively hazing birds to displace them from areas where oil is located may be counterproductive, because few alternative habitats are available to birds at this time. For sea ducks arriving via overland routes, the benefit of spill containment and cleanup would be minor until they begin reentering the marine environment following breeding. By this time, the oil would have weathered and would be expected to have minor impact to birds. Indirect effects resulting from intake of contaminated prey organisms may be higher under broken-ice than open-water conditions, because reduced cleanup capability would provide a longer interval for exposure and uptake by such organisms. Accumulation of oil in coastal marshes and adjacent habitats could present a hazard to departing males following breeding and females with young following nesting as they move to offshore areas. Prior to freeze-up, most sea ducks and other waterfowl and shorebirds are not likely to be present in great numbers, and oil present in areas with broken ice may have weathered and become less hazardous to birds. Long-tailed ducks, eiders, and glaucous gulls are at risk until later in the fall than most other species because they remain in the area longer than most other species.

A winter spill entering the environment during the ice-covered period could affect birds after the ice melts in the spring. Migrating loons and waterfowl concentrated in open water near river deltas or other nearshore areas could come in contact with oil or could feed on contaminated prey. Losses from a spill contacting terrestrial habitats would not be expected to result in substantial effects to bird populations.

4.11.4.9 Mammals

Terrestrial Mammals

For this analysis, it is assumed that a very large spill from a blowout would occur during the peak of the mosquito season within the TLH caribou insect-relief area north and east of Teshekpuk Lake. Any terrestrial mammals in the immediate vicinity of the blowout could be contacted by oil falling onto the surrounding tundra and open water. Loss of thermoregulation would not be a factor, except possibly in young caribou calves. Larger, more mobile animals such as caribou, bears, and moose would likely move out of the area affected by the blowout, reducing their exposure. Smaller, less mobile animals might not be able to move out of the affected area, resulting in greater mortality among these species. Some animals could be killed from exposure to toxins, either absorbed through the skin or ingested during feeding. Ingestion typically results in pulmonary aspiration that can be lethal or predispose the animal to infections. Terrestrial mammals would be temporarily disturbed or displaced by cleanup and site rehabilitation activities. At this time of year, TLH caribou would be aggregated into large groups for insect avoidance. If a blowout occurred in the vicinity of an aggregation, a relatively large number (100+) of caribou could be exposed to oil fallout. Movement of insect-harassed caribou in the vicinity of the blowout could be disrupted during the duration of the blowout and the following period of cleanup, reducing caribou foraging efficiency. If foraging efficiency was reduced enough to result in reduced weight gain, there could be greater over-winter mortality or a corresponding reduction in parturition the following year. This effect would only last for 1 season and would not result in long-term reduction in the population size unless followed or preceded by a few years of higher mortality or lower parturition from other factors. The amount of habitat affected by such a spill would be minimal when compared to the amount of caribou habitat available on the North Slope.

Marine Mammals

For marine mammals to come in contact with produced oil from even a very large oil spill (VLOS) would require that the spill occur off-shore (which is unlikely due to the very limited area off-shore available for leasing in the planning area and its close proximity to the shore – there would be no benefit to actually drilling in these areas because of the expense of design requirements when any potential petroleum could be reached more efficiently from an onshore directional drilling approach) or that it occur in the coastal environment or that it enter a major river system near the coast during the broken ice period. During other periods clean-up and containment would be expected to prevent most produced fluids from entering the marine environment. Therefore, the likelihood of a spill impacting marine mammals is dependent not only on the location of the spill but the season.

Winter

The area immediately off-shore of the planning area is covered by land-fast ice during winter. Any spilled fluids would remain on the top of the ice and the success of clean-up efforts is expected to be high. No marine mammals with the exception of polar bear (see T&E section) would be present so the only threat would be from oil not cleaned up that enter the marine system during break-up. The amount of oil would likely be very low and unlikely to have significant effects on marine mammals.

Broken Ice (Fall Freezeup and Spring Breakup)

During these periods clean-up and containment success is comprised by environmental conditions. Spilled fluid reaching the marine environment would generally be contained within the ice. In the case of a fall spill, it is expected that most fluid would be frozen within the ice and released during summer melt. This could affect marine mammals using the near shore environment either through direct contact of impacts to prey species. The number of animals affected would be dependent on the aerial extent of the spill and its location as well as the animals behavior. Animals that typically occur in groups (beluga whales) may have more individuals affected, but may have a relatively lower overall chance of coming into contact with a spill because they are not evenly distributed. Actual numbers and movement rates would also influence the number impacted. Active clean-up efforts during the melt may cause some animals to avoid the area reducing the chance of contact.

A spill during spring-break-up that reached the lead system or became trapped under ice could impact relatively more animals because the oil may become concentrated (constrained by the ice) in the open water where migrating and foraging marine mammals are also concentrated – increasing the potential for contact and subsequent injury and mortality.

Summer

If a VLOS occured along the shore during the summer open-water season or was transported via a river to the marine system the spill would contaminate marine waters although containment efforts are expected to be successful during this season. Small numbers of spotted seals could be exposed to the spill. Smaller numbers of other marine mammals, such as ringed and bearded seals, and beluga whales that generally occur offshore during the summer, could be exposed to oil if the spill were to spread offshore. If spotted seals were to be oiled and suffer lethal effects from the spill, the small population could take a few years or more to recover.

Losses of other marine mammals to the spill would likely be small, with recovery of populations expected within one generation.

4.11.4.10 Threatened and Endangered Species

Bowhead Whale

As with other marine mammals, if a VLOS were to occur in an area along the northern coast of the planning area or along a river tributary to the Beaufort Sea, oil could enter the nearshore marine environment and potentially be transported to offshore areas. The season during which a spill occurred would influence the potential impact, during winter bowhead whales are not present and the nearshore area is inaccessible due to land-fast ice. Cleanup and containment would be expected to be successful and any remnant oil would be likely to only a negligible impact.

Fall Freezeup

Under most circumstances, contact with whales migrating through offshore waters during the open-water season would be brief. In some years, however, bowhead whales have been observed very near shore between Point Barrow and Cape Halkett during the westward fall migration. For example, 77 individuals were observed feeding near the shoreline between Smith Bay and Dease Inlet in September 2000 (Treacy 2002a). If bowhead whales were feeding in an area when spilled oil was present, contact could be prolonged and some of the oil could be ingested. It is not known whether a brief exposure, especially of volatile components, would have effects on lung or eye function. A late fall spill could become entrained in the pack ice and the oil could be released into leads when the ice melted. However, a winter spill would likely melt out in July, so it is not likely that oil would be melted out of the ice in time to contact spring leads during the whale migration that spring but could affect whales during summer and fall (dependent on detection and cleanup success) and prey.

Spring Breakup

During their spring migration, bowhead whales often are concentrated in the spring lead system as they move through the Chukchi Sea, past Point Barrow, and eastward through the Beaufort Sea. This behavior makes them vulnerable to any oil entering the spring lead system. Once oil enter the lead system it would be somewhat contained and occur at higher concentrations than an open water spill. Potentially increasing the chance of contact and the number of whales contacted. The relative increased concentration could also increase the likelihood of severe injury and subsequent mortality. Oil released in broken ice conditions would be more difficult to clean up and more likely to enter the spring lead system.

Summer

If a VLOS occured along the shore during the summer open-water season or was transported via a river to the marine system the spill would contaminate marine waters although containment efforts are expected to be successful during this season and spread would be limited. An early summer or late summer spill would have the most potential to impact bowheads. Spills during other time periods would likely exert a greater impact on prey species in the near shore environment.

Oil Effects

Effects of an oil spill on bowhead whales would include oiling of the skin, inhalation of hydrocarbon vapors or oil, ingestion oil or contaminated prey, fouling of the baleen, reduction of food supply, displacement from feeding areas, and possibly death. The effect of fouling baleen has not been investigated adequately; the long filamentous bowhead whale baleen may be prone to more serious fouling than the coarser baleen of some other species, thereby depriving bowhead whales of a greater degree of normal function. The number of whales contacting spilled oil would depend on the timing and duration of the spill, ice conditions, effectiveness of containment and clean-up operations, and the whales' ability or inclination to avoid contact. Based on conclusions from studies that have examined the effects of oil spills on cetaceans, external exposure to spilled oil is unlikely to have serious effects on bowhead whales. Most whales exposed to spilled oil would likely experience temporary, nonlethal effects, although lethal effects to some individuals could occur.

Spectacled and Steller's Eiders

A VLOS could affect both male and female eiders in the terrestrial environment during nest initiation (early to late June) and females and young from June into late August. A spill reaching marine waters could impact male spectacled eiders, from mid- to late June to late July, and females, from late June to early September, may stage in offshore waters of the planning area prior to migration (TERA 1999; Fischer et al. 2002; Troy 2003).

Broken Ice (Fall Freezeup and Spring Breakup)

A terrestrial spill during fall freezeup would have no direct effect on eiders as they are not present. Some long-term habitat damage/loss would occur but to a relatively small amount of the planning area. A VLOS that reached rivers or the marine environment could cause impacts to eiders during late spring as oil moved through the river systems possibly entering near river lakes and ponds as a result of flood flows. Because of the low density of spectacled eiders and the almost complete absence of Steller's eiders the number of birds impacted would likely be relatively low when compared to the population. Any oil reaching the marine environment during spring break-up could affect migrating eiders in open water near river deltas; however, most spectacled eiders likely migrate overland in the spring and few birds would be affected. A summer spill could impact staging eiders prior to fall migration. The number of eiders affected potentially could total tens to low hundreds of individuals. Using average estimated spectacled eider density calculated from USFWS survey data in the central Beaufort Sea area from Harrison Bay to Brownlow Point, and average severity of spill-trajectory paths (and thus, exposure of birds to oil), a USFWS model estimated an average of only two eiders would be exposed to a large spill (5,912 barrels) within 30 days in July (Stehn and Platte 2000). However, in late July, one group of 100 individuals was observed, suggesting a potential for much higher mortality should a spill occur in an area of relatively high spectacled eider density. The greatest potential for spectacled eiders to be impacted by an offshore oil spill would occur in deeper offshore waters of Harrison Bay rather than in offshore waters to the east or shallower nearshore waters. An oil spill could also contaminate prey populations in eider foraging areas at any time of year that could result in secondary impacts on eiders, affecting productivity and/or survival. Likewise, negative effects of a spill on shoreline and coastal marsh habitat could affect eiders when the eiders are moving from onshore brood-rearing areas to the marine environment, or in subsequent years.

Winter

A winter VLOS would have the same potential impacts as one occurring during fall freezeup however cleanup would be expected to be much more successful thus substantially reducing risk of adverse impacts. Some habitat damage would occur as a result of cleanup efforts; however.

Summer

A large onshore spill released in the planning area during the summer season could affect pre-nesting, nesting, and brood-rearing spectacled or Steller's eiders. In the immediate vicinity of the spill, some habitat contacted by oil would become unsuitable for nesting, brood-rearing, or foraging, and oil entering freshwater aquatic habitats could spread more widely, including into river deltas and nearshore marine habitats. Direct mortality could occur from loss of insulating capabilities of feathers should eiders come in contact with oil, or by ingesting contaminated prey. Oil that may come in contact with eggs, either directly or through contact with partially oiled feathers of incubating adults, can negatively impact embryonic development.

Effects of Oil-Spill Prevention and Response

A spill that occurred during the summer open-water period would be expected to cause some Steller's eider and spectacled eider mortality. Most mortality would likely occur offshore where concentrations of staging spectacled eiders are greatest. Containment, recovery, and clean-up activities for a large spill would be expected to involve hundreds of workers and numerous boats, aircraft, and onshore vehicles operating over an extensive area for more than 1 year. The presence of such a workforce in open water conditions would be likely to act as a general hazing factor by displacing any eiders from the immediate area of activity and potentially away from areas contaminated with oil. Active hazing may also help to reduce the number of eiders that may be affected by an oil spill by targeting specific birds or groups in danger of coming in contact with oil with specific hazing tactics. Special areas of concern include important foraging areas for spectacled eiders located in marine waters adjacent to the planning area in Smith and Harrison bays.

Containment and oil recovery operations following a large spill that entered the marine environment under broken-ice conditions at meltout or freezeup would be less effective than for a spill in open water. A spill during the ice-covered period or during broken ice conditions may be less likely to spread than a spill occurring during the open-water period and few eiders would be expected to occur in offshore areas during periods with ice coverage. Many spring migrants likely would occupy open overflow areas off river mouths that are open early and are near nesting areas; the most effective response could be to focus containment and clean-up efforts in such areas. During the broken-ice season, the hazing effect of clean-up activity or the active hazing of eiders to displace them from contaminated areas could be counterproductive, because there are few alternative habitats that could be occupied at this time. Since most spectacled eiders arrive in the area via overland routes (TERA 1999), the benefit of spill containment and cleanup would be greatest in nesting habitat. Indirect effects resulting from the intake of contaminated prey organisms could be higher under broken-ice than open-water conditions, because reduced cleanup capability could provide a longer interval for exposure and uptake by such organisms. Entrapped oil in coastal marsh and adjacent habitats could present a hazard to departing males after breeding and to females with young after nesting as they move to offshore waters. Few spectacled eiders are likely to be present in the offshore waters of the planning area by late September, and oil present in broken ice at this time likely would not impact many eiders.

Some mortality could also result in terrestrial or coastal habitats where post-breeding males or unsuccessful females or females with recently fledged young could be affected by an oil spill. An onshore spill in summer could enter lakes and streams used by eiders and could result in some mortality to nesting or brood-rearing eiders. As spectacled eiders nest in low densities, disturbance of nesting eiders by onshore clean-up activities would not be expected to result in large increases in nest abandonment or overall decreases in productivity. If clean-up activities were to displace females with broods from coastal habitats prematurely into the more saline offshore marine environment, it could result in decreased duckling survival. Helicopter support traffic and human presence would probably cause the greatest disturbance associated with oil-spill clean-up activity.

Polar Bear

Polar bear are ice dependent and rare on shore during summer. Any summer terrestrial VLOS would have negligible impact to polar bears, although some denning habitat may be damaged during clean-up efforts. Only spills during other periods that reached marine waters or the coast line would be expected to impact polar bears. However, due to generally wide distribution and low density very few animals would be expected to be impacted if any.

Broken Ice (Fall Freezeup and Spring Breakup)

The primary effect of a VLOS during these seasons may be disturbance from clean-up efforts causing females to move to other denning areas in the fall, or resulting in early den emergence and thus lower reproductive success in the fall. Direct impacts would be similar to other marine mammals, with spring break up and concentration of oil in the leads most likely to result in adverse impacts. Any spill that impacted polar bear would also impact their prey species. Some polar bears not impacted directly by oil may experience reduced foraging success and others may be impacted through eating contaminated prey.

Winter

Like spills during the broken ice periods, the primary impact may result from clean up activities causing den disturbance and reduced reproductive success. This may be more likely for winter spills as clean-up efforts should be more effective and thus intense (more vehicles and people). However, because clean up is expected to be more effective the potential effects of oil contamination are lower.

4.11.4.11 Cultural Resources

Because cultural resources in the planning area are located at or near the ground surface, a spill that occurred during the summer would have a greater effect on these resources than a spill that occurred during the winter. Oil spilled during winter, however, could impact cultural resources if the warm oil melted the snow and permafrost and impacted the underlying cultural resources. While the contamination of the cultural resources would render some of the data recovery valueless, the clean-up procedures would create even greater impacts. Since cultural resources are nonrenewable, the effects could result in loss of site integrity.

4.11.4.12 Subsistence

Effects on subsistence-harvest patterns from a 120,000-bbl oil spill could potentially displace and cause a functional loss of habitat to CAH, TLH, and WAH caribou. Effects to subsistence would occur as this important subsistence resource became unavailable or undesirable for use, or experienced long-term (more than 5 years) population and productivity effects. Exposure of bowhead whales to spilled oil could result in lethal effects to some individuals, injury to many more, and long-term contamination of the fatty tissues and possible chronic ill health for many of the whales exposed to the spill. Large numbers of spotted seals could be exposed to the spill and suffer losses, with population recovery taking several years, and hunters decreasing harvests of subsistence resources for many years due to contamination. Losses of other marine mammals should be smaller, with recovery occurring within 1 year. If a large spill were to occur when large concentrations of molting, staging, or migrating birds were present, tens of thousands of birds could be contacted by oil, representing a loss to regional populations and affecting subsistence and sports uses in the Y-K Delta as well as locations along the Pacific Flyway. A substantial portion of resident fish populations could be harmed or killed by a very large oil spill, and other populations could become contaminated. Access to subsistence hunting areas and subsistence resources and the use of subsistence resources could change if an oil spill reduced the availability of resources or altered their distribution patterns. Extra-regional efforts to acquire subsistence foods would be undertaken, possibly taxing the resources of other subsistence regions.

The communities of Anaktuvuk Pass, Atqasuk, Barrow, Wainwright, and Nuiqsut would be affected by a very large oil spill in the planning area. Even if few individual subsistence species were directly lost or displaced, a very large oil spill could potentially contaminate essential nearshore whaling areas and onshore terrestrial hunting and fishing areas, causing effects when the additive impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together.

4.11.4.13 Sociocultural Systems

Sociocultural systems in the communities of Anaktuvuk Pass, Atqasuk, Barrow, Wainwright, and Nuiqsut could undergo long-term individual, social, and institutional stress and disruption from a 120,000-bbl spill. It is expected that considerable stress and anxiety would occur over the loss of subsistence resources, contamination of habitat and subsistence resources, fear of the health effects of eating contaminated wild foods, fear of changes to harvest regulations (e.g., quotas), and the need to depend on the knowledge of others about environmental contamination (Fall 1992, McMullen 1993). Individuals and communities would be increasingly stressed during the time it would take to modify subsistence-harvest patterns by selectively changing harvest areas (if such areas were even available) and there would be increased costs and risks associated with travel and hunting in unfamiliar areas. Associated cultural activities, such as the organization of subsistence activities among kinship groups and the relationships among those who customarily process and share subsistence harvests, would also be modified or would decline.

A 120,000-bbl spill would be expected to affect individuals and social systems in ways similar to the effects of the Exxon Valdez oil spill. As shown by that spill, some individuals found a new arena for pre-existing personal and political conflict, especially over the dispensation of money and contracts. In the smaller communities, clean-up work produced a redistribution of resources, creating new schisms in the community and increasing social stresses. Many members of small communities were on the road to sobriety before the spill; after the spill, some

people began drinking again, leading to the re-emergence of numerous alcohol-related problems (such as child abuse, domestic violence, and accidents). Institutional effects included additional burdens on local governments, disruption of existing community plans and programs, strain on local officials, difficulty dealing with Exxon, community conflict, disruptions of customary habits and patterns of behavior, emotional effects and stress-related disorders from confronting environmental degradation and death, and violation of community values (Endter-Wada 1992). Post-spill stress resulted from the seeming loss of control over individual and institutional environments, as well as from secondary episodes such as litigation, which produced secrecy over information, uncertainty over outcomes, and community segmentation (Smythe 1990). Attempts to mitigate social effects were often ineffective because of concerns over litigation, causing a reluctance to intervene out of fear that these actions might benefit adversaries in legal battles (IAI 1990b, 1998; Human Relations Area Files, Inc. 1994; ADFG 1995). In response to spill hazards, there has been a resurgence in traditional strategies for responding to resource shortages, which in traditional times, and following the spill, resulted in an increase in sharing, a renewal and strengthening of social connections with extended family members and friends, and a cooperative approach to subsistence activities within and between the most affected communities.

4.11.4.14 Environmental Justice

Alaska Iñupiat Natives, a recognized minority, are the predominant residents of the NSB, the area potentially most affected by planning area exploration and development. An oil spill could affect Iñupiat Natives because they rely on subsistence foods and there could be cumulative effects to subsistence resources and harvest practices.

In the unlikely event that a large spill occurred and contaminated essential nearshore whaling areas and onshore terrestrial hunting and fishing areas, major environmental justice effects could occur, stemming from contamination of the shoreline, tainting concerns, clean-up disturbance, and disruption of subsistence practice. Oil-spill contamination and cleanup could potentially displace and cause a functional loss of habitat to CAH, TLH, and WAH caribou, as well. Such impacts would cause damage to subsistence resources, which would result in disproportionately high effects on Alaskan Natives. Oil-spill contamination of subsistence foods would be the main health-related concern. Most potential effects to subsistence resources and subsistence harvests would be mitigated to some extent, though not eliminated.

4.11.4.15 Coastal Zone Management

A very large spill would be very unlikely. If a spill of this size were to occur, the spill itself and the resulting clean-up activities could have effects on one or more subsistence resources and access to those resources in the vicinity of the spill.

The NSB Coastal Management Program policies relate to impacts that are "likely and cannot be avoided or mitigated" and "development that will likely result in significantly decreased productivity of subsistence resources of their ecosystems." An oil spill of this size would be accidental and the probability of such an event is very low. Therefore, it is not considered to be a "likely" event, and would not introduce conflict with policy standards.

The NSB CMP Best Effort Policy 2.4.5.1(b) states that access to subsistence resources can be restricted when there is no feasible and prudent alternative. This policy could pertain to clean-up activities. If it is determined that there are no feasible and prudent alternatives to these activities, there would be no conflict with this policy.

Based on the low probability of an oil spill event of this magnitude, and on compliance with existing regulations for spill prevention and response, existing management practices, and proposed lease stipulations and ROPs, no conflicts with CMP policies are anticipated.

4.11.4.16 Recreation Resources

The impacts to recreation and wilderness resources would primarily relate to reductions in aesthetic values and naturalness associated with visible oil sheen and residues on vegetation and water. The effects on recreation opportunities would be short term in nature and would dissipate as cleanup and rehabilitation proceeded. Effects on wilderness values would depend on the care taken during the clean-up process. If the scars on the landscape from clean-up activities were effectively rehabilitated, the long-term effect on wilderness values would be minor.

The likelihood of a large spill affecting the Colville River would depend on where oil and gas development occurred. A large oil spill could possibly impact water quality and outstandingly remarkable values, particularly wildlife, archeology, and paleontology, and, to some extent, recreation and geology. Impacts on archeology, paleontology and geology would likely depend on the care taken during clean up of the spill. Recreation values would recover over time. Such impacts would not change the determination that the Colville River is not currently suitable for designation as a Wild and Scenic River.

4.11.4.17 Visual Resources

A very large spill that occurred along the shore during the summer open-water season would have little effect on visual resources overall, as the spill would be confined to beach areas or the adjacent shoreline vegetation, up to six miles from the source. The occurrence of a very large spill along the shore during the winter could have a similar effect if it were released from the ice during the following spring breakup. If a very large spill were to occur onshore during winter, little effect would occur as the spill would be absorbed in snow and ice and removed prior to breakup. Only if clean-up was not possible, would the spill materials be released into underlying vegetation and soils. A very large spill during summer would impact visual resources by the visible oil and the resulting damage to the underlying vegetation of up to 62,000 acres. Some of the spill would occur on already disturbed areas such as drill pads and production areas, however, it is possible that up to 20% of a spill would occur as far as six miles from the source and impact vegetation in otherwise undisturbed areas.

4.11.4.18 Economy

The estimate of employment used in this analysis for a very large spill of 120,000 bbl is based on the most relevant historical experience of a spill in Alaskan waters–the Exxon Valdez oil spill of 1989. The employment estimate is based on a ratio of workers to barrels spilled in the Exxon Valdez spill. The Exxon Valdez spill was 240,000 bbl. This spill generated enormous employment that rose to the level of 10,000 workers doing direct cleanup work in relatively remote locations. Smaller numbers of clean-up workers returned in the warmer months of each subsequent year until 1992. The planning area spill scenario assumes the spill would occur on land, not near the Beaufort or Chukchi seas, and not on possible drainage systems near and leading to those seas. If the spill occurred on land not near a sea, the number of workers could be less than the proportional effort to clean up the Exxon Valdez spill. If the spill occurred on a drainage system near a sea, then the clean-up effort would likely be close to that required to

clean up the Exxon Valdez spill. Based on the experience of this spill, an oil spill of 120,000 bbl would generate approximately 5,000 jobs for 6 months in the first year, declining to zero by the third year following the spill.

In the case of the Exxon Valdez spill, numerous local residents quit their jobs to work on the cleanup, often at substantially higher wages, which generated inflation in the local economy (Cohen 1993). Anecdotal information indicates that housing rents in Valdez in 1989 increased by 25% in some cases to 6-fold in others, and inflated rents continued into 1990. The NSB would not experience similar inflation effects because cleanup activities would be managed and staged out of existing enclave-support facilities. The number of workers actually used to clean up a possible 120,000-bbl oil spill would depend on a number of factors, including which procedures were called for in the oil-spill contingency plan; the level of preparedness (equipment and training) of the entities responsible for cleanup; how efficiently the cleanup activities were executed; and the degree of coordination between the numerous responsible entities.

4.11.4.19 Public Health

In the event of a very large oil spill, considerable stress and anxiety would occur over the loss of subsistence resources, contamination of habitat and subsistence resources, fear of the health effects of eating contaminated wild foods, fear of changes to harvest regulations (e.g., quotas), and the need to depend on the knowledge of others about environmental contamination (Fall 1992, McMullen 1993). Reductions in subsistence game populations, displacement of game, and fears of contamination could combine to substantially reduce subsistence game intake. If this occurred, the prevalence of diabetes and related metabolic disorders would be expected to increase substantially, based on evidence reviewed in **section 4.3.19**. Food insecurity would increase markedly, and unless sharing networks and government programs were able to respond rapidly, hunger and potentially (though less likely) malnutrition could result.

Social pathology would likely increase. In the case of the Exxon Valdez spill, many members of small communities were on the road to sobriety before the spill; after the spill, some people began drinking again, leading to the re-emergence of numerous alcohol-related problems (such as child abuse, domestic violence, and accidents). Institutional effects included additional burdens on local governments, disruption of existing community plans and programs, strain on local officials, difficulty dealing with Exxon, community conflict, disruptions of customary habits and patterns of behavior, emotional effects and stress-related disorders from confronting environmental degradation and death, and violation of community values (Endter-Wada 1992). Post-spill stress resulted from the seeming loss of control over individual and institutional environments, as well as from secondary episodes such as litigation, which produced secrecy over information, uncertainty over outcomes, and community segmentation (Smythe 1990). Attempts to mitigate social effects were often ineffective because of concerns over litigation, causing a reluctance to intervene out of fear that these actions might benefit adversaries in legal battles (IAI 1990b, 1998; Human Relations Area Files, Inc. 1994; ADFG 1995).

In parallel with both increased social pathology and more difficult hunting conditions, injury rates and mortality could also increase.

Oilspill contamination of subsistence resources could lead to increases in contaminant-related health problems such as cancer and neurodevelopmental delays: these problems are felt to be relatively less likely because experience has shown that people tend to avoid resources they perceive as potentially contaminated, but chronic persistent low-level contamination many years after the spill could cause incremental increases in these problems.

The impacts to the social determinants of health possible after a very large oil spill are among the most concerning issues in the very large oil spill scenario. If, as in the Exxon Valdez oil spill, the disruption of sharing networks and increases in social pathology were extensive and persistent, substantial decreases in social capital could occur, with ramifications for not only psychosocial health but physical health as well (Ritchie and Gill, 2004; Marmot and Wilkinson 2003).

4.11.5 Comparison of Alternatives

Under the various alternatives presented in this amendment, the risk of the occurrence of a very large spill and the likelihood that such a spill would contact specific resources would vary. The risk of a very large spill would be different under each alternative because the projected level of oil and gas activities and production would be different. The likelihood of a very large spill contacting specific resources would be different under each alternative because the area available for oil and gas leasing would be different. The potential impacts of a very large spill would not differ among the alternatives.

The likelihood of a very large blowout spill occurring would be highest under Alternative C because the greatest number of wells and the greatest volume of production are projected under that scenario. The likelihood of contact with surface resources would vary by resource. In general, the likelihood of contact would be highest under Alternative C because the greatest area would be made available for oil and gas leasing, exploration, and development.

Under Alternative A, about 30% fewer wells are projected to be drilled and about 30% less oil is projected to be produced than under Alternative C. Given these scenarios, it is assumed, therefore, that the risk of a very large blowout spill would be about 30% less under the Alternative A than under Alternative C.

Under Alternative B, about 20% fewer wells are projected to be drilled and about 20% less oil is projected to be produced than under Alternative C. Given these scenarios, it is assumed, therefore, that the risk of a very large blowout spill would be about 20% less under Alternative B than under Alternative C.

Under Alternative D, about 5% fewer wells are projected to be drilled and about 10% less oil is projected to be produced than under Alternative C. Given these scenarios, it is assumed, therefore, that the risk of a very large blowout spill would be 5 to 10% less under Alternative D than under Alternative C.

4.12 ENERGY REQUIREMENTS AND CONSERVATION POTENTIAL OF VARIOUS ALTERNATIVES AND MITIGATION MEASURES

There would be no unusual energy requirements for implementing any of the alternatives or their associated mitigation measures (including lease stipulations and required operating procedures). Generally speaking, energy requirements and conservation potential would be proportional to the amount of oil and gas activities conducted under each alternative.

Chapter V: Consultation and Coordination

CHAPTER V: CONSULTATION AND COORDINATION

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CHAPTER V: CONSULTATION AND COORDINATION

5.1 INTRODUCTION

This section summarizes the public and agency outreach BLM has engaged in as it has considered changes to the 1998 Northeast NPR-A ROD. This outreach occurred during both the Amended and Supplemental IAP/EIS processes. This outreach included keeping the public and agencies informed of the process and offered opportunities for the public and agencies to express their concerns and suggest how BLM should proceed. The section also identifies the individuals who prepared the Amended IAP/EIS and this supplement thereto.

5.2 AMENDED IAP/EIS

5.2.1 Formal Scoping

BLM published a Notice of Intent to Plan (Notice), and a Call for Nominations and Comments (Call), in the *Federal Register* on June 23, 2003, initiating the Amended IAP/EIS process. The Notice and Call asked the public to help BLM identify issues and resources relevant to planning for potential oil and gas leasing. BLM also asked oil companies to identify their areas of interest within the planning area. The Notice and Call stated that the period during which comments would be taken on the proposal would be from June 23 through September 30, 2003. On September 15, 2003, BLM published a Notice of Extension that extended the period for accepting scoping comments until October 31, 2003. Comments on the proposal could be submitted in writing to the BLM Project Manager or via an interactive website (http://nenpra.ensr.com).

Public notices announcing the scoping period were placed in newspapers in or near locations where public meetings were held. These newspapers included the Anchorage Daily News (October 5 and 7, 2003), the Fairbanks Daily News Miner (October 5 and 8, 2003), and the Arctic Sounder (October 9, 16, and 23, 2003).

Six public scoping meetings were held throughout Alaska between October 7 and November 13, 2003. Meetings (and dates) were as follows: Anchorage (October 7), Fairbanks (October 8), Nuiqsut (October 15), Barrow (October 16), Anaktuvuk Pass (October 28), and Atqasuk (November 13). The scoping meetings were conducted in an open-house style. Informational displays were set up, and a formal presentation was given to provide the public with additional information on program goals and objectives. The formal presentation was followed by a public comment session. Written and oral comments were accepted at these meetings, and a court reporter prepared a transcript of the oral comments. A translator was also provided for the public meetings in Atqasuk, Anaktuvuk Pass, Barrow, and Nuiqsut.

In addition, informal public meetings were held in 2004 in Nuiqsut (January 19) and Barrow (January 26) to describe the range of alternatives.

5.2.2 Agency and Organization Meetings

BLM conducted a two-day workshop in Anchorage, on December 3-4, 2003, to describe and develop stipulations and Required Operating Procedures for use in the Northeast National Petroleum Reserve – Alaska (NPR-A). Attendees included representatives from Federal, state, and local agencies, and representatives from the village of Nuiqsut. In addition, BLM held ongoing discussions with numerous Federal, state, and local agencies and organizations.

5.2.3 Agencies and Organizations Contacted

The following agencies and organizations were contacted during the Amended IAP/EIS process:

- **Federal Agencies**
  Minerals Management Service
  National Oceanic and Atmospheric Administration Fisheries Service
  National Park Service
  U.S. Army Corps of Engineers
  U.S. Department of Energy
  U.S. Environmental Protection Agency
  U.S. Fish and Wildlife Service
  U.S. Geological Survey

- **State of Alaska Agencies**
  Department of Fish and Game
  Department of Natural Resources

- **Municipal Governments**
  City of Anaktuvuk Pass
  City of Anchorage
  City of Atqasuk
  City of Barrow
  City of Bethel
  City of Fairbanks
  City of Kaktovik
  City of Nuiqsut
  City of Point Hope
  City of Wainwright
  Native Village of Point Lay
  North Slope Borough

The following is a partial list of organizations and officials who were notified that the Final Amended IAP/EIS was available for review and comment:

- **Organizations**
  Arctic Slope Regional Corporation
  Alaska Center for the Environment
  Alaska Coalition
  Alaska Conservation Foundation
  Alaska Eskimo Whaling Commission
  Alaska Miners Association

Alaska Oil and Gas Association
Alaska Outdoor Council
Alaska Wildlife Alliance
Alyeska Pipeline Service Company
Anadarko Petroleum Corporation
ARCO Alaska
Arctic Research Commission
Arctic Slope Native Association
Arctic Slope Regional Corporation
Barrow Whaling Captains Association
BP Exploration (Alaska), Inc.
Bristol Bay Native Corporation
Center for Biological Diversity
Chevron USA
ConocoPhillips Alaska Inc.
Defenders of Wildlife
Ducks Unlimited Inc.
Evergreen Resources of Alaska
Exxon
Forest Oil Corporation
Japan National Oil Corporation
Kuukpik Corporation
Marathon Oil Company
National Audubon Society
Natural Resources Defense Council
Northern Alaska Environmental Center
Resource Development Council
Sierra Club
Sun-West Oil and Gas Incorporated
The Nature Conservancy
Total E&P USA, Inc.
Trading Bay Energy Corporation
Ukpeagvik Iñupiat Corporation
Unocal Oil and Gas Division
Union Texas Petroleum Company
Wilderness Society
Wildlife Management Institute
World Wildlife Fund

- **Elected Officials**

Governor of Alaska Frank Murkowski
U.S. Senator Ted Stevens
U.S. Senator Lisa Murkowski
U.S. Representative Don Young
Alaska State Senators
Alaska State Representatives

5.2.4 Government-to-Government Consultation

BLM consulted with federally–recognized tribes, consistent with the Presidential Executive Memorandum dated April 29, 1994, on Government-to-Government Relations with Native American Tribal Governments; Executive Order 13175 dated November 6, 2000, on Consultation and Coordination with Indian Tribal Governments; and the January 18, 2001, Department of the Interior – Alaska Policy on Government-to-Government Relations with Alaska Native Tribes. The BLM formally consulted with federally–recognized tribes in Alaska before taking action or undertaking activities that may have a substantial, direct effect on federally–recognized tribes, or their assets, rights, services, or programs. To this end, formal Government-to-Government consultation with the following federally–recognized traditional governments was initiated by written correspondence on August 27, 2003, prior to scoping for the amendment:

- Native Village of Anaktuvuk Pass
- Native Village of Atqasuk
- Native Village of Barrow
- Native Village of Nuiqsut
- Iñupiat Community of the Arctic Slope

The letter sent to all of the tribal governments described the proposed action, and invited the tribes to call if they had questions or wanted to set up individual meetings with the Authorized Officer of the BLM Northern Field Office (currently BLM's Fairbanks District Office). The letter also invited the tribal councils to attend the scoping meeting scheduled for their community. All tribal governments were called approximately two weeks after the letters were sent, in order to solicit questions or potential concerns, and to make sure that the information in the letter was received and understood.

In addition, BLM participated in a number of meetings with federally–recognized tribes and state and local governments in which the topic of the amendment was on the agenda. These meetings, which are listed below, include BLM Subsistence Advisory Panel Meetings, where each panel member is a representative of either a tribal or local government, as well as meetings with the NSB and the local communities of Nuiqsut and Barrow.

- Native Village of Nuiqsut Tribal Council, October 15, 2003 in Nuiqsut, Alaska
- Subsistence Advisory Panel, November 3, 2003 in Atqasuk, Alaska
- Native Village of Atqasuk, November 4, 2003 in Atqasuk, Alaska
- Native Village of Nuiqsut Tribal Council, Kuukpik Subsistence Oversight Panel, and the City of Nuiqsut, December 3-4, 2003 in Anchorage, Alaska
- Subsistence Advisory Panel, December 11, 2003 in Barrow, Alaska
- Kuukpik Subsistence Oversight Panel, January 19, 2004 in Nuiqsut, Alaska
- Native Village of Nuiqsut Tribal Council, January 20, 2004 in Nuiqsut, Alaska
- North Slope Borough, City of Barrow, and Native Village of Barrow, January 26, 2004 in Barrow, Alaska
- Subsistence Advisory Panel, March 16, 2004 in Nuiqsut, Alaska
- Kuukpik Subsistence Oversight Panel, March 18, 2004 in Nuiqsut, Alaska
- Subsistence Advisory Panel, June 10, 2004 in Barrow, Alaska
- Subsistence Advisory Panel, November 9, 2004 in Nuiqsut, Alaska

Comments and issues brought forward through consultation with Native tribal governments focused on the following topics: 1) the purpose and need for amending the 1998 Northeast IAP/EIS; 2) protection of subsistence resources; 3) anticipated levels of oil and gas and related activities (including seismic exploration) as a result of leasing new areas; 4) development of roads to villages and bridges across rivers and streams; 5) retaining the stipulations as they currently exist in the 1998 Northeast IAP/EIS ROD; 6) use of traditional knowledge in making decisions; and 7) local employment opportunities.

During consultation, tribal leaders made a few specific recommendations. These recommendations included making stipulations and ROPs more restrictive; protecting subsistence use areas and resources; limiting restrictions on access to subsistence areas near oil developments; making core calving areas and insect-relief areas for the Teshekpuk Lake caribou herd unavailable for leasing; protecting the primary migration route of the Teshekpuk Lake caribou herd, which is located between the eastern shore of Teshekpuk Lake and the coast; protecting goose molting areas; restricting shipping traffic in areas used by bowhead whales; protecting cabins and camps; seeking ways to increase employment opportunities with oil companies on the North Slope; and adequately addressing the health and social impacts of oil and gas leasing on the residents of the North Slope. All comments and recommendations were received verbally during meetings with individual tribal councils.

5.2.5 Public Review and Comment on the Draft Amended IAP/EIS

The Notice of Availability (NOA) of the Draft Amendment to the Northeast National Petroleum Reserve-Alaska Integrated Activity Plan/Environmental Impact Statement (IAP/EIS) and the Announcement of Public Subsistence-Related Hearings Schedule was published in the Federal Register on June 9, 2004. The public comment period was originally scheduled from June 9, 2004, through August 8, 2004, however, it was extended through August 23, 2004. Public notices announcing the comment period were placed in newspapers with circulation in or near locations where public meetings were held. These newspapers included the Arctic Sounder (August 8 and 15, and October 28, 2004) and Tundra Drums (August 12 and November 11, 2004). Public service announcements were broadcasted on radio station KBRW from July 27 through August 17, and during late October through November 2004. The BLM issued a press release on June 9, 2004, notifying the public that the Draft Amended IAP/EIS was available for public review, and the schedule for public comment and ANILCA 810 subsistence hearings. Notices were posted at public gathering places in Nuiqsut, Barrow, Anaktuvuk Pass, and Atqasuk, all located on the North Slope of Alaska, and Bethel, Alaska, located on the Yukon Delta. Information on the Draft Amended IAP/EIS was also posted on the interactive website (http://nenpra.ensr.com). The public was able to access the website to download a copy of the Draft Amended IAP/EIS and provide their comments (including attachments). Comments and attachments posted to the website were incorporated into a database for later analysis by the core planning team.

Public and subsistence hearings were held in Anchorage on June 28, Fairbanks on June 29, Washington D.C. on July 1, Anaktuvuk Pass on August 3 and November 8, Nuiqsut on August 9 and December 1, Atqasuk on August 10 and November 4, Barrow on August 12 and November 5, and Bethel on August 17 and November 11, for the BLM to provide an overview of the alternatives and to take public comments and subsistence testimony. Over 214,660 comments were received on the Draft Amended IAP/EIS. These included letters, electronic mail, facsimiles, comments and attachments posted to the project website, and comments provided at the public hearings. A summary of the comments received and specific comments and responses

are presented in Volume II, Chapter 6, of the Final Amended IAP/EIS. All comment letters were reproduced on the CD located in the back pocket of Volume I of the Final Amended IAP/EIS.

5.2.6 Development of the Final Preferred Alternative

After completion of the public hearings and closure of the public comment period, the core planning team, resource staff, and management met to review the comments and alternative proposals and to develop the BLM's final Preferred Alternative for the Final Amended IAP/EIS. Several alternative proposals were received. These included proposals to close or open additional areas to leasing and development; place greater or lesser restrictions on the types of activities allowed under stipulations and ROPs; and combine elements of two or more alternatives (e.g., select Alternative A, but replace the 1998 stipulations with stipulations and ROPs developed for Alternative B).

During the comment period on the Draft Amended IAP/EIS, the USFWS submitted a proposal that would have left approximately 296,000 acres northeast of Teshekpuk Lake unavailable to oil and gas leasing. The full text of the agency's letter can be read on the CD included with the Final IAP/EIS (see Comment Number 197619; U.S. Fish and Wildlife Service at Anchorage). This is an increase of 83,000 and 85,000 acres that would have been made unavailable for leasing as compared to Alternative B (Preferred Alternative in Draft Amended IAP/EIS; 213,000 acres unavailable for leasing; Map 2-2), and the final Preferred Alternative (Alternative D; 211,000 acres in Teshekpuk Lake unavailable for leasing; Map 2-4), respectively. The USFWS believed their proposal would provide additional protection for molting brant and other wildlife.

An alternative proposal was also submitted by ConocoPhillips Alaska, Inc. The full text of the company's letter can be read on the CD included with the Final IAP/EIS (see Comment numbers 196557 and 197611; ConocoPhillips Alaska, Inc.). Their proposal would have allowed for oil and gas leasing, exploration, and development within portions of the area closed to leasing under Alternative B. ConocoPhillips believed that their proposal would provide adequate protection for caribou and molting geese, while providing additional lands for oil and gas development.

BLM took these proposals and other public comments into consideration when reviewing the alternatives developed for the Draft Amended IAP/EIS. Based on these comments, BLM developed a final Preferred Alternative (Alternative D) for the Final Amended IAP/EIS. This alternative allowed for some oil and gas development in the 213,000-acre no-lease area identified under Alternative B (Map 2-4). However, this alternative also provided protection for geese, caribou, subsistence, and other resources found to the north and east of Teshekpuk Lake, by prohibiting permanent oil and gas facilities (excluding pipelines and roads in some areas) on 374,000 acres (Alternative B protects 213,000 acres), and limiting the amount of development (maximum of 300 acres) that could occur within each of seven lease tracts to the north of the lake (Map 2-4). This alternative also deferred leasing of Teshekpuk Lake (211,000 acres). With the development of the final Preferred Alternative, BLM had developed a range of alternatives that encompassed the range of alternatives submitted by the public and agencies.

5.2.7 Development of the Record of Decision

BLM received approximately 500 comments from the public following the Notice of Availability (January 28, 2005) of the Final Amended IAP/EIS. Many of the comments objected to the contents of BLM's Preferred Alternative as presented in the Final Amended IAP/EIS and restated arguments that were made by various organizations and individuals during the comment period on the Draft Amended IAP/EIS. The majority of the comments did not contain any recommendations for technical improvements of the document. However, BLM considered all of the comments received, including those from the NSB, the Kuukpik Corporation representing the City of Nuiqsut, and the Ducks Unlimited Pacific Region, which all contained various recommendations for changes to the Final Amended IAP/EIS Preferred Alternative. The ROD adopted clarifications and minor modifications to the Preferred Alternative in response to these comments. All of the modifications made in the ROD provided additional mitigation of the impacts of oil and gas activities on surface resources, thereby increasing the protection provided for important surface values in the planning area, including Special Areas.

5.3 SUPPLEMENTAL IAP/EIS

In undertaking a Supplemental IAP/EIS, BLM is not required to conduct formal scoping (40 CFR 1502.9(c)(4)). Nevertheless, in issuing a Notice of Intent to prepare the supplement on December 4, 2006, BLM invited the public to comment on issues of interest, and particularly sought recommended mitigation measures. The comments received expressed general support or opposition to leasing additional areas of the planning area (particularly north and east of Teshekpuk Lake) and to changes in the 1998 stipulations. They also offered suggestions for public health-related mitigation measures, changes to the management alternatives presented in the Amended IAP/EIS, and perspectives on post-Amended IAP/EIS events that should be considered in the Supplemental IAP/EIS. Finally, some letters cited recent studies that have provided fresh information for this Supplemental IAP/EIS. The following organizations/agencies submitted comments:

State of Alaska
Alaska Center for the Environment, Alaska Coalition, Alaska Wilderness League, Audubon Alaska, Natural Resource Defense Council, Northern Alaska Environmental Center, Sierra Club, The Wilderness Society, Trustees for Alaska, Center for Biological Diversity, Earthjustice (joint letter)
Anadarko Petroleum
ConocoPhillips Alaska, Inc.
Ducks Unlimited
North Slope Borough
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
Western Arctic Caribou Herd Working Group
Wildlife Conservation Society
Wildlife Society

BLM has taken the comments into consideration, including presenting in this supplement potential public health-related mitigation measures, assuring that the alternatives remain adequate, revising the analysis to address events that have occurred since the Amended IAP/EIS, and incorporating information from recent studies in the analysis.

BLM has updated and benefited from the advice of the Alaska Resource Advisory Council, a fifteen-member group representing a broad spectrum of Alaskan government, industry, and Native and environmental organizations at public meetings in December 2006 and May 2007 in Anchorage and February 2007 in Barrow.

BLM has especially benefited from the participation of the North Slope Borough as a cooperating agency in the Supplemental IAP/EIS. BLM and the NSB entered into a Memorandum of Understanding on January 17, 2007 that defined their respective roles and responsibilities in the IAP/EIS. The NSB has reviewed sections of the IAP/EIS as they have been produced and offered helpful corrections and suggestions for improvement, including suggestions for mitigation measures. The Borough has made an important contribution by developing the discussion on public health, a subsection not previously incorporated in BLM's NPR-A plans. (Although this document has benefited from the input from the many NSB specialists with extensive knowledge of the people, resources, and uses of the planning area, BLM bears ultimate responsibility for the Supplemental IAP/EIS).

BLM initiated tribal consultation through letters sent to six tribes in December 2006. The letters were sent to:

- Native Village of Anaktuvuk Pass
- Native Village of Atqasuk
- Native Village of Barrow
- Native Village of Nuiqsut
- Native Village of Wainwright
- Iñupiat Community of the Arctic Slope

The letters to the tribes initiated government-to-government consultation and requested input particularly on measures that could reduce impacts to resources and uses that could be impacted by oil and gas activities. The tribes were invited to provide input not only during the initial commenting period, but throughout the planning process.

In a letter dated February 1, 2007, BLM reinitiated consultation with the Alaska SHPO as part of Section 106 consultation under the NHPA to determine how proposed industrial activities could impact cultural resources listed on or eligible for inclusion in the NRHP. Consultation with the SHPO is ongoing and will be completed by the time of the signing of the ROD. Formal consultation with the SHPO also may be required during permitting and NEPA review of individual oil industry proposals.

BLM reinitiated consultation with the USFWS and NOAA Fisheries Service as required under Section 7 of the ESA with letters of March 20, 2007. The letters included a description of the supplement's contemplated actions, notified the agencies that BLM intends to prepare a new BA, and identified the threatened, endangered, and proposed species that the BA would address. BLM will prepare a Biological Assessment; the ROD will not be signed until the Biological Opinion is completed and consultation is concluded.

BLM is consulting with the State of Alaska to ensure that the mandates of the CZMA are met. The required compliance documentation will be included in the Supplemental IAP/EIS ROD.

5.4 LIST OF PREPARERS

5.4.1 List of Preparers of the Amended IAP/EIS

The following individuals participated in preparing the Amended IAP/EIS. The list of individuals includes the individuals' company/agency and role in the Amended IAP/EIS. Companies included ENSR International (ENSR); Booz, Allen, and Hamilton (BAH); LGL Alaska Research Associates, Inc. (LGL); Northern Economics, Inc. (NEI); Planera, Inc. (Planera), and Stephen R. Braund and Associates, Inc. (SRBA). Bureau of Land Management offices included the Alaska State Office (ASO) and the Northern Field Office (NFO; currently the Fairbanks District Office). MMS specialists were located in Anchorage.

- Anderson, Kimberly (ENSR; Technical Writer)
- Armstrong, Gary (BAH; Alternatives Development Specialist)
- Baldivieso, Alan (SRBA; GIS Specialist)
- Banet, Art (BLM-ASO; Coal Resources and Seismic)
- Berg, William (ENSR; Geology and Oil and Gas Exploration and Development)
- Berry, Robert (ENSR; Water Resources)
- Bibles, Dean (BAH; IAP/NEPA Advisor)
- Bisson, Henri (ASO; BLM State Director)
- Braund, Stephen (SRBA; Cultural Resources and Subsistence)
- Brelsford, Taylor (BLM-ASO; Sociocultural Economist)
- Brumbaugh, Rob (BLM-ASO; Physiography)
- Burden, Patrick (NEI; Economics)
- Childs, Susan (BLM-ASO; BLM Project Manager)
- Craig, Jim (MMS; Petroleum Geology, Oil and Gas Assessment, and Oil and Gas Exploration and Development Activities)
- Cuyno, Leah (NEI; Economics)
- Delaney, Roger (BLM-NFO; Recreation and Wilderness Resources)
- Dougherty, Sean (BAH; GIS Specialist)
- Ellsworth, Steven (ENSR; Assistant Project Manager)
- Erickson, Ara (ENSR; Editor and Document Production)
- Fechhelm, Robert (LGL; Fisheries)
- Flaming, Barry (ENSR; Soil, Sand, and Gravel)
- Flora, Susan (BLM-NFO; Hazardous Materials)
- Funk, Dale (LGL; Vegetation and Wetlands and Floodplains)
- Gilders, Michelle (LGL; Terrestrial Mammals)
- Goodwin, Randy (BLM-NFO; Off Highway Vehicles and Recreation)
- Grover, Elizabeth (SRBA; Section 106 Consultation and Subsistence)
- Hammond, Tim (BLM-NFO; GIS Specialist)
- Haskell, Sean (LGL; Caribou Biology)
- Hilsinger, Erik (SRBA; Traditional Knowledge and Subsistence)
- Huebner, Darek (BLM-NFO; Soils, Gravel, and Physiography)
- Kasterin, Mike (BLM-ASO; Socioeconomics)
- Kemnitz, Richard (BLM-NFO; Water Resources)
- Kelly, Lon (BLM-ASO; Recreation)
- King, Robert (BLM-NFO; Cultural Resources and Paleontological Resources)
- Kirschbaum, Sara (BAH; GIS Specialist)
- Kleven, Mike (BLM-NFO; Northern Field Office Environmental Planning Coordinator)
- Kosnik, Kristine (BLM-NFO; GIS Specialist)

- Koss, Lee (BLM-ASO; Air Quality and Soils)
- Kunz, Michael (BLM-NFO; Cultural Resources and Paleontological Resources)
- Long, Alissa (ENSR; Wetlands)
- McCaa, Craig (BLM-NFO; Public Affairs Specialist)
- McClain, Holli (BLM-NFO; Visual Resources)
- McIntosh, Stacie (BLM-NFO; Cultural Resources, Subsistence, and ANILCA 810 Analysis)
- Meares, Don (BLM-NFO; Physiography, Sand and Gravel, Oil and Gas Exploration-Environmental Status)
- Mundy, Nancy (NEI; Economics)
- Munson, Kim (ENSR; Paleontology)
- Nigro, Debbie (BLM-NFO; Avian Species and Threatened and Endangered Species)
- Nordmann, Jerry (BLM-NFO; Lands/Realty)
- Paulson, Merlyn (ENSR; Visual Resources)
- Paulus, Stuart (ENSR; Project Manager)
- Payne, John (BLM-ASO; Threatened and Endangered Species)
- Randall, Valerie (ENSR; NEPA Specialist)
- Rodrigues, Robert (LGL; Avian Biology Specialist)
- Scheetz, Vince (ENSR; Air Quality)
- Schneider, Robert (BLM-NFO; NFO Director)
- Servoss, Shawn (BLM-NFO; GIS Specialist)
- Sharpe, Margaret (ENSR; Editor)
- Strom, Bernhard (Planera; Realty, Land Use, Transportation, and Recreation)
- Thomas, Jane (ENSR; Petroleum Engineering and Spills and Hazardous Materials)
- Tol, Dennis (BLM-ASO; Fisheries)
- Whitman, Mathew (BLM-NFO; Fisheries)
- Williams, Michael (LGL; Marine Mammals)
- Wilson, Curt (BLM-ASO; Chief Planner/Environmental Coordinator)
- Wolf, Janet (ENSR; Public Participation)
- Worley, Mike (BLM-NFO; Lands/Realty)
- Worthey, Marshall (BAH; GIS Specialist Public Lands)
- Yokel, Dave (BLM-NFO; Terrestrial Mammals and Vegetation)

5.4.2 List of Preparers of the Supplemental IAP/EIS

The following individuals have participated in preparing the Supplemental IAP/EIS. The list of individuals includes the individuals' institutional affiliation and role in the Supplemental IAP/EIS. The institutions include the Bureau of Land Management (BLM), primarily its Alaska State Office (AKSO) and Fairbanks District Office (FDO), and the North Slope Borough (NSB).

- Archer, Scott (BLM-Denver Service Center; Meteorology and Climate, Air Quality)
- Ardizzone, Chuck (BLM-AKSO; Subsistence, Sociocultural Systems, Environmental Justice, ANILCA 810)
- Ashley, Noah T., Ph.D. (NSB; Wildlife Biologist)
- Bacon, Joshua (NSB; Biologist)
- Brumbaugh, Robert (BLM-AKSO; Petroleum Resources, Sand and Gravel Resources, Oil and Gas scenario)
- Diel, Bill (BLM-AKSO; Oil and Gas scenario)

- Delaney, Roger (BLM-FDO; Recreational and Wilderness Resources)
- Ducker, James, Ph.D. (BLM-AKSO; IAP/EIS Planning Leader, Special Areas)
- Flora, Susan (BLM-FDO; Hazardous Materials)
- George, Craig (NSB; Wildlife Biologist)
- Gibson, Caron (BLM-AKSO, Technical Editor)
- Hanns, Cyd (NSB; Wildlife Research Specialist)
- Harvey, Susan (NSB;Consultant)
- Hollen, Bruce (BLM-AKSO; Birds, Mammals, BLM Special Status Species)
- Hughes, Layla (NSB; Assistant Borough Attorney)
- Kasterin, Mike (BLM-AKSO; Economy)
- Kelly, Lon (BLM-FDO; Arctic Field Office Manager)
- Kemnitz, Richard (BLM-FDO; Water Resources, Wetlands and Floodplains)
- King, Robert, Ph.D. (BLM-AKSO; Paleontological Resources, Cultural Resources)
- Kleven, Mike (BLM-FDO; Fairbanks IAP/EIS Planning Coordinator)
- Koss, Lee (BLM-AKSO; Soils Resources)
- Kunz, Mike, Ph.D. (BLM-FDO; Paleontological Resources, Cultural Resources)
- Lavin, Susan (BLM-AKSO; Land Ownership, Land Uses)
- Lohman, Tom (NSB; Environmental Resource Specialist)
- Lonnie, Thomas R. (BLM-AKSO; State Director)
- Holli McClain (BLM-FDO; Outdoor Recreation Planner)
- McIntosh, Stacie (BLM-FDO; Subsistence, Sociocultural Systems, Environmental Justice, ANILCA 810)
- Nigro, Debbie (BLM-FDO; Birds)
- Overbaugh, Bill (BLM-AKSO; Recreational and Wilderness Resources)
- Pederson, Michael (NSB; Subsistence Research Coordinator)
- Person, Brian, Ph.D. (NSB; Wildlife Biologist)
- Rosa, Cheryl, Ph.D., DVM (NSB; Research Veterinarian)
- Schneider, Robert (BLM-FDO; District Manager)
- Standley, Jeanne (BLM-AKSO; Vegetation)
- Standley, Larry (BLM-AKSO; Physiography, Soils Resources, Water Resources, Wetlands and Floodplains, Coastal Zone Management)
- Suydam, Robert (NSB; Wildlife Biologist)
- Svejnoha, Wayne (BLM-AKSO; Hazardous Materials)
- Taylor, Carol (BLM-AKSO; Coastal Zone Management)
- Theisen, Skip (BLM-FDO; Wildland Fire)
- Tol, Dennis (BLM-AKSO; Fish)
- Wernham, Aaron, M.D. (NSB; Consultant\Physician)
- Whitman, Matthew (BLM-FDO; Fish)
- Worley, Mike (BLM-FDO; Land Ownership, Land Uses)
- Yokel, Dave, Ph.D. (BLM-FDO; Vegetation, Terrestrial Mammals)

Appendix A: ANILCA SECTION 810 ANALYSIS OF SUBSISTENCE IMPACTS

APPENDIX A

ANILCA SECTION 810 ANALYSIS OF SUBSISTENCE IMPACTS

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APPENDIX A

ANILCA § 810 ANALYSIS OF SUBSISTENCE IMPACTS

In 2001, the President created the National Energy Policy Development Group (NEPDG), consisting of the Vice-President and other key cabinet members. The primary task of the group was to "develop a national energy policy designed to help the private sector, and, as necessary and appropriate, state and local governments, and promote dependable, affordable, and environmentally sound production and distribution of energy for the future" (NEPDG 2001). In May 2001, the NEPDG released the National Energy Policy report, a comprehensive list of findings and key recommendations that were adopted by the President, and that form the basis of the President's National Energy Policy. Specifically, the policy directs the Secretary of the Interior to "consider additional environmentally responsible oil and gas development, based on sound science and the best available technology, through further lease sales in the National Petroleum Reserve – Alaska," and that "such consideration should include areas not currently leased within the northeast corner of the National Petroleum Reserve – Alaska." To that end, the Bureau of Land Management (BLM) initiated a process to amend the 1998 Integrated Activity Plan for the Northeast Planning Area of the National Petroleum Reserve – Alaska (NPR-A). The Amended IAP/EIS was issued in January 2005, and was followed by a record of decision (ROD) in January 2006. On September 25, 2006, the U.S. District Court for the District of Alaska found that the Amended IAP/EIS failed to adequately address the cumulative impacts increased activities in the Northeast NPR-A planning area will have when combined with increased activity in the Northwest NPR-A planning area. The court vacated that ROD and enjoined the Secretary of the Interior from further action in the Northeast planning area under that ROD. This Supplemental IAP/EIS provides additional analysis necessary to fully address the deficiencies noted by the court and updates relevant sections of the document with new information.

Chapters 3 (Affected Environment) and 4 (Environmental Consequences) of the Supplemental Northeast NPR-A Integrated Activity Plan/Environmental Impact Statement (Supplemental IAP/EIS) provide a detailed description of both the affected environment of the planning area and the potential adverse effects of the various alternatives to subsistence and to subsistence resources. This appendix uses the detailed information presented in the Supplemental IAP/EIS to evaluate the potential impacts to subsistence pursuant to Section 810(a) of the Alaska National Interest Land Conservation Act (ANILCA).

A.1 SUBSISTENCE EVALUATION FACTORS

Section 810(a) of ANILCA, 16 USC § 3120, requires that an evaluation of subsistence uses and needs be completed for any federal determination to "withdraw, reserve, lease, or otherwise permit the use, occupancy or disposition of public lands." As such, an evaluation of potential impacts to subsistence under ANILCA § 810(a) must be completed for the Supplemental IAP/EIS. ANILCA requires that this evaluation include findings on three specific issues:

- The effect of use, occupancy, or disposition on subsistence uses and needs;
- The availability of other lands for the purpose sought to be achieved; and

- Other alternatives that would reduce or eliminate the use, occupancy, or disposition of public lands needed for subsistence purposes (16 USC § 3120).

The evaluation and findings required by ANILCA § 810 are set out for each of the four alternatives considered in the Supplemental IAP/EIS.

A finding that the proposed action may significantly restrict subsistence uses imposes additional requirements, including provisions for notices to the State of Alaska and appropriate regional and local subsistence committees, a hearing in the vicinity of the area involved, and the making of the following determinations, as required by Section 810(a)(3):

- Such a significant restriction of subsistence uses is necessary, and consistent with sound management principles for the utilization of the public lands;
- The proposed activity will involve the minimal amount of public lands necessary to accomplish the purposes of use, occupancy, or other disposition; and
- Reasonable steps will be taken to minimize adverse effects upon subsistence uses and resources resulting from such actions.

To determine if a significant restriction of subsistence uses and needs may result from any one of the alternatives discussed in the Supplemental IAP/EIS, including their cumulative effects, the following three factors in particular are considered:

- The reduction in the availability of subsistence resources caused by a decline in the population or amount of harvestable resources;
- Reductions in the availability of resources used for subsistence purposes caused by alteration of their normal locations and distribution patterns; and
- Limitations on access to subsistence resources, including from increased competition for the resources.

A significant restriction to subsistence may occur in at least two instances: 1) when an action substantially reduces populations or their availability to subsistence users, and 2) when an action substantially limits access by subsistence users to resources. Chapter 3 (Affected Environment) of the Supplemental IAP/EIS provides information on areas and resources important for subsistence use, and the degree of dependence of affected villages on different subsistence populations. Chapter 4 (Environmental Consequences) provides much of the data on levels of reductions and limitations under each alternative, and is used to determine whether the action would cause a significant restriction to subsistence. The information contained in the Supplemental IAP/EIS is the primary data used in this analysis.

A subsistence evaluation and findings under ANILCA § 810 must also include a Cumulative Impacts analysis. Section A.2, below, begins with evaluations and findings for each of the four alternatives discussed in the Supplemental IAP/EIS. Finally, the cumulative case, as discussed in Chapter 4 (Environmental Consequences) of the Supplemental IAP/EIS, is evaluated. This approach helps the reader to separate the subsistence restrictions that would potentially be caused by activities proposed under the four alternatives from those that would potentially be caused by past, present, and future activities that could occur, or have already occurred, in the surrounding area.

When analyzing the effects of the four alternatives, particular attention is paid to those communities who have the potential to be most directly impacted by the proposed actions—

Anaktuvuk Pass, Atqasuk, Barrow, Nuiqsut, and Wainwright. These communities are located within or adjacent to the Northeast Planning Area. The cumulative case expands the analysis to include the entire North Slope, including indirect effects to communities located in other areas of the state (i.e., the Yukon-Kuskokwim Delta), to assess any impacts to subsistence that may result because of negative effects to migratory subsistence species.

In addition to ANILCA, Environmental Justice, as defined in Executive Order 12898, also calls for an analysis of the effects of federal actions on minority populations with regard to subsistence. Specifically, Environmental Justice is:

The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic group should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies.

Section 4-4 of Executive Order 12898, regarding the Subsistence Consumption of Fish and Wildlife, requires federal agencies to collect, maintain, and analyze information on the consumption patterns of populations who principally rely on fish and/or wildlife for subsistence, and to communicate to the public any risks associated with the consumption patterns. To this end, the subsistence analyses of all alternatives, located in Chapter 4 (Environmental Consequences) of the Supplemental IAP/EIS, have been reviewed and found to comply with Environmental Justice.

A.2 ANILCA § 810(a) Evaluations and Findings for All Alternatives and the Cumulative Case

The following evaluations are based on information relating to the environmental and subsistence consequences of alternatives A through D, and the cumulative case as presented in Chapter 4 (Environmental Consequences) of the Supplemental IAP/EIS. The stipulations discussed in Chapter 2 (Alternatives) of the Supplemental IAP/EIS are also considered for the alternatives to which they apply. The evaluations and findings focus on potential impacts to the subsistence resources themselves, as well as access to resources, and economic and cultural issues that relate to subsistence use.

A.2.1 Evaluation and Findings for Alternative A (No Action Alternative)

Alternative A of the Supplemental IAP/EIS is the No Action Alternative. Selection of this alternative would result in continued management of the Northeast NPR-A as specified in the 1998 Northeast National Petroleum Reserve – Alaska IAP/EIS Record of Decision (ROD; 1998 Northeast IAP/EIS ROD). In effect, Alternative A is the preferred alternative from the previous 1998 EIS, and as such, a subsistence evaluation as required by the ANILCA § 810 has already been completed. The evaluation and findings presented here reaffirm the previous conclusion that impacts to subsistence as a result of this alternative would be minimal.

A.2.1.1 Evaluation of the Effect of Use, Occupancy, or Disposition on Subsistence Uses and Needs

Under Alternative A, 13% of the planning area would remain unavailable (87% available) for oil and gas leasing, including much of the Teshekpuk Lake Special Area, and important waterfowl and caribou habitat. All of the special areas and site-specific prohibitions, as well as the 79 stipulations defined in the ROD, would remain in effect.

The analysis of Alternative A on subsistence presented in **section 4.3.12, *No Action Alternative, Subsistence***, considers the effects of non-oil and gas activities, the effects of oil and gas activities, the effects of oil spills, and the effectiveness of the stipulations required by BLM, as discussed in the 1998 Northeast IAP/EIS ROD. The analysis concludes that the No Action Alternative would have a negligible effect on subsistence species and on access to subsistence resources, and that mitigation measures developed by BLM in conjunction with local communities would serve to minimize, to the extent possible, impacts to subsistence use by the communities of Anaktuvuk Pass, Nuiqsut, Atqasuk, Wainwright or Barrow.

Effects to subsistence resources by non-oil and gas activities consist primarily of those actions associated with research. Numerous studies are conducted on a year-round basis on the North Slope, including aerial surveys by fixed-wing aircraft or helicopter, or ground surveys on foot or by off-highway vehicle (OHV), all of which have the potential to disturb animals. The most frequent complaint voiced by local subsistence users is that a large amount of aerial disturbance to animals occurs each field season in conjunction with scientific studies (Subsistence Advisory Panel [SAP] Minutes, June 6, 2002 meeting; SAP Minutes, August 22, 2002 meeting). Many of the scientific studies that currently occur are a result of stipulations imposed on oil and gas activities in the planning area; however, these same mandatory stipulations serve to minimize the potential effects of conducting research. Based on the analysis presented in Chapter 4 (Environmental Consequences), the effects of non-oil and gas activities on the species utilized by subsistence users is expected to be localized and short-term, and to have no regional population effects.

Oil and gas-related activities allowed under the No Action Alternative include seismic exploration, exploratory drilling, and development/production. Each of these activities has the potential to displace animals, with exploration potentially causing temporary displacement in the area of activity, and development/production potentially causing multi-year displacement during construction, and until the animal becomes habituated to the resultant infrastructure. Access by subsistence users could be impacted if the animals they wish to hunt have been displaced to areas much farther from their normal hunting grounds. However, many of the stipulations in the 1998 ROD would minimize the effects of oil and gas activities on animal populations, their range, and access to hunting areas by subsistence users (see **section 4.3.12.3, *Effectiveness of Stipulations***).

Oil spills have the potential to impact subsistence species as well as subsistence harvest patterns, depending on the amount and the location of the spill. Small spills are unlikely to cause great damage, especially if contained on land. Large spills are unlikely to occur during the exploration phase of oil development, but could occur once production infrastructure and facilities were in place. Several stipulations pertaining to spills and spill response are included under the No Action Alternative, which serve to reduce the potential impacts of oil spills to subsistence species and use.

As stated in **section 4.3.13.4, *Sociocultural Systems, Conclusion***, the 1998 Northeast IAP/EIS ROD was the result of several years of collaboration between the communities near the planning area, local governments and agencies, and BLM. The stipulations comprise essential protections for subsistence resources, cabins, camps, and river corridors, and also define the system of conflict negotiation to be used by permittees, leaseholders, subsistence users, and the BLM. Residents living on the North Slope, especially those in the village of Nuiqsut, view the 1998 stipulations, river setbacks, and designated special areas as a negotiated compromise between the Iñupiat people, the federal government, and the oil industry. Retention of the 1998 Northeast IAP/EIS ROD is favored by many individuals, local agencies, and local governments, as the 1998 Northeast IAP/EIS ROD is viewed as an effective plan that allows for oil and gas activity and the Iñupiat way of life to effectively coexist (ENSR 2004 Public Scoping Summary Report for the Amendment to the National Petroleum Reserve – Alaska Integrated Activity Plan/Environmental Impact Statement).

A.2.1.2 Evaluation of the Availability of Other Lands for Oil and Gas Exploration and Development

The Naval Petroleum Reserves Production Act of 1976 (NPRPA), as amended, gave the Secretary of the Interior the authority to conduct oil and gas leasing in the Northeast NPR-A. However, the law prohibited petroleum production from occurring in the NPR-A until authorized by Congress. In 1980, Congress granted that authorization and directed the Secretary of the Interior to undertake a program of competitive leasing of potential oil and gas tracts in the Reserve. The President's energy policy directs the Secretary of the Interior to "consider additional environmentally responsible oil and gas development, based on sound science and the best available technology, through further lease sales in the National Petroleum Reserve – Alaska." BLM is undertaking this Supplemental IAP/EIS to fulfill the mandates of the President's energy policy, as well as BLM's responsibilities to manage these lands under authority of the NPRPA and Federal Land Policy and Management Act (FLPMA), and other authorities cited elsewhere in this EIS. Alternative A would continue the authorization of oil and gas exploration or development activities in the Northeast NPR-A under the 1998 Northeast IAP/EIS ROD. Other lands managed by BLM are either too remote for economically viable oil and gas production, or have a low probability of containing sufficient quantities of oil or gas. State and Native Corporation Lands cannot be considered in a BLM plan, and under BLM policy other BLM lands outside of Alaska are not considered under ANILCA.

A.2.1.3 Evaluation of Other Alternatives that Would Reduce or Eliminate the Use, Occupancy, or Disposition of Public Lands Needed for Subsistence Purposes

Alternatives that would reduce or eliminate the use of public lands needed for subsistence include: 1) making more land in the Northeast NPR-A unavailable for oil and gas leasing, or 2) not allowing oil and gas activity to occur. However, neither of these alternatives would satisfy the underlying purpose of the IAP/EIS to make more lands available for leasing. The Secretary of the Interior has directed BLM to consider additional lands in the Northeast NPR-A to the extent it can be done in an environmentally sound manner. Reducing the number of acres available for energy development would contradict this direction, and would go against the President's stated National Energy Policy. Additionally, the 1998 Northeast IAP/EIS ROD allowed the BLM to enter into contracts with several oil companies, by leasing land for oil and gas exploration. All of these leases are still in effect. **Section 2.5, *Alternatives Considered but Eliminated from Detailed Analysis*** of the Supplemental IAP/EIS discusses other alternatives that were considered, but eliminated from detailed analysis.

A.2.1.4 Findings

Alternative A would not significantly restrict subsistence uses and needs. The impacts to subsistence resources and access discussed above would be minimal, or would be adequately mitigated by special area designation and stipulations under which the lessee/permittee must operate. This finding applies to Anaktuvuk Pass, Atqasuk, Barrow, Wainwright, and Nuiqsut.

A.2.2 Evaluation and Findings for Alternative B

Alternative B, as well as the stipulations and required operating procedures (ROPs) accompanying it, takes into consideration all comments and concerns generated during the scoping process, as well as the stated direction from the Secretary of the Interior to look at lands previously unavailable for leasing in the planning area. Alternative B of the Supplemental IAP/EIS makes approximately 95% of all lands within the planning area available for oil and gas leasing, which includes approximately 387,000 acres that were formerly off-limits to leasing. Management practices would emphasize performance-based stipulations and ROPs on surface activities, consultation with local residents, and coordinated scientific studies to protect wildlife habitat, subsistence use areas, and other resources. In addition, approximately 213,000 acres northeast of Teshekpuk Lake that are currently unavailable for oil and gas leasing would remain unavailable for leasing, to provide for protection of wildlife and subsistence resources.

A.2.2.1 Evaluation of the Effect of Use, Occupancy, or Disposition on Subsistence Uses and Needs

The analysis of Alternative B on subsistence is presented in **section 4.4.12, *Alternative B, Subsistence***. This analysis considers the effects of non-oil and gas activities, the effects of oil and gas activities, the effects of oil spills, and the effectiveness of the associated stipulations and ROPs as presented by BLM. The analysis concludes that the effect of Alternative B on subsistence would be greater than that of Alternative A, but would remain localized and would not significantly affect subsistence species, access to subsistence resources, or subsistence use by the communities of Anaktuvuk Pass, Nuiqsut, Atqasuk, Wainwright or Barrow.

At issue in this evaluation are the differences between Alternative A and Alternative B, and whether these differences would be significant enough to cause a substantial impact to the populations of subsistence species, to displace these species from their current habitat, or to limit access to current, traditional hunting areas by subsistence users under Alternative B. Alternative B primarily differs from the No Action Alternative in the following regards:

- Performance-based stipulations and ROPs would replace the 79 prescriptive stipulations in the 1998 Northeast IAP/EIS ROD. Stipulations refer to requirements that the leaseholder must comply with and are attached to the lease document, whereas ROPs are requirements that any operator working in the Northeast NPR-A would be required to follow, and would be attached to permits for activity.
- Some of the 79 stipulations from the 1998 Northeast IAP/EIS ROD that are already required by existing regulation or law would not have a corresponding stipulation or ROP under Alternative B. This does not mean that the lessee or permittee would be able to ignore the actions/activities covered by the original stipulations, only that these actions/activities would be covered by law or regulation, and, therefore, must be followed in order to comply with the law. This approach would actually serve to strengthen the

intent, in that lessees/permittees would not mistakenly believe that they could be granted an exception to the stipulation using the BLM exception process.

- An additional 387,000 acres would be available for oil and gas leasing. However, within these additional acres, no permanent oil and gas facilities would be allowed within ¼ mile of the shore of identified goose-molting lakes, or within ¾ mile of the coast. Approximately 213,000 acres located in the goose molting/caribou habitat use area northeast of Teshekpuk Lake would remain unavailable for oil and gas leasing.
- Surface activity, including exploratory and delineation wells, would be allowed within the former "No Surface Activity" zone south of Teshekpuk Lake. However, the construction of permanent facilities would not be allowed until the lessee has conducted a study that includes a minimum of 3 years' worth of data on caribou movements.
- "Sensitive Area Consultation" zones from the 1998 Northeast IAP/EIS ROD would be replaced by ROP H-1, which requires consultation with the North Slope Borough (NSB), the Subsistence Advisory Panel, and affected communities, regardless of where the activity would take place.
- Permanent oil and gas facilities would not be allowed within ¼ mile of lakes identified as "Deep Water Lakes." The 1998 Northeast IAP/EIS ROD did not allow permanent facilities within ¼ mile of fish-bearing lakes in a large area south of Teshekpuk Lake, but each individual lake was not specifically identified.

Of the differences between alternatives A and B, only two would potentially cause Alternative B to substantially affect subsistence resources or their use: the availability of additional land for oil and gas leasing from within the area north and west of Teshekpuk Lake, and the removal of the "No Surface Occupancy" zone south of Teshekpuk Lake. Other changes, such as updating the stipulations and adopting ROPs to conform to an adaptive management approach, would not reduce the level of protection afforded.

It is expected that impacts to terrestrial mammals and subsistence use in the vicinity of Teshekpuk Lake would be greater under Alternative B than under the No Action Alternative, particularly with respect to caribou calving and insect-relief habitat, given the additional 387,000 acres that would be available for oil and gas leasing. However, the 213,000 acres that would be unavailable to leasing are important to caribou migrating between calving and insect-relief areas and the wintering grounds. This area, as well as the stipulations that have been developed to further protect caribou found near Teshekpuk Lake, would serve to protect the resource from substantial decline at the population level (see **sections 4.4.9.1, *Terrestrial Mammals*,** and **4.4.12.2, *Subsistence, Oil and Gas Exploration and Development Activities***).

Impacts are also expected to be greater for birds, especially brant, under Alternative B when compared to Alternative A (see **section 4.4.8, *Birds***). The communities of Barrow and Nuiqsut utilize the planning area for harvesting birds, with birds comprising between 1.8–2.6% of each community's annual harvest (Fuller and George 1997). The species most heavily harvested by residents include white-fronted geese, black brant, and king and common eiders. As many as 30% of the Pacific flyway population of brant may be present in the Teshekpuk Lake goose molting area during the molting period, making it one of the single most important areas for molting brant overall. As a result, impacts to brant in the planning area that would result in population level declines have the potential to affect harvesters across the North Slope, in Northwest Alaska, and in the Yukon-Kuskokwim Delta. However, the primary reason for making 213,000 acres unavailable to leasing under Alternative B is to protect important habitat for caribou and molting geese. In addition, numerous lease stipulations and ROPs were developed to protect birds and their habitat within the planning area, including the K-

stipulations, which provide for a number of measures designed to reduce the effects of development on molting geese by establishing setbacks from lake shorelines within which construction of permanent oil and gas facilities would not be permitted, regulating water extraction from lakes, and minimizing or eliminating disturbance from aircraft during critical periods.

Impacts to vegetation, fish, and other resources used for subsistence purposes are expected to be minor (see **sections 4.4.5, *Vegetation*; 4.4.7, *Fish*; and 4.4.9, *Mammals***).

Under Alternative B, the greatest potential impact to subsistence use would be the removal of the "No Surface Activity" zone, which extends from the west side to the east side of the planning area in a band south of Teshekpuk Lake. Comments received during the scoping process for the amendment stressed the importance of protecting essential caribou movement/migration corridors, located both to the east and the west of Teshekpuk Lake. The construction of permanent facilities, such as pipelines, roads, and production pads, within these narrow corridors could result in displacement of the Teshekpuk Lake Caribou herd, if the caribou were unable to get to their known insect-relief habitat during periods of intense insect harassment. Furthermore, removal of the "No Surface Activity" zone, in addition to opening more lands for leasing, would allow permanent facilities to be constructed within much of the Teshekpuk Lake Herd calving area. While such construction might not affect the population of the herd, it could result in a dramatic shift in the current use-area of the caribou, resulting in displacement of the herd. Stipulation K-5 would serve to minimize the potential disturbance to caribou by requiring a 3-year study of caribou movements in the vicinity of the facility, before BLM would authorize construction.

In addition to the potential displacement of subsistence resources under Alternative B, the elimination of the "No Surface Activity" zone, as well as the additional acres available for leasing, could result in future infrastructure such as pipelines, roads, production pads, and wells. Oil industry infrastructure on the east side of the Colville River has resulted in the nonuse of this area by the residents of Nuiqsut, who do not feel comfortable hunting near or around oil developments. If enough economically recoverable oil was discovered to warrant additional development in the Nuiqsut, Atqasuk, or Barrow traditional subsistence use areas, hunters could avoid the development. The result would be an overall reduction in lands used for subsistence purposes. Effective communication and consultation by the oil industry, local communities, and the BLM would be essential when, and if, development were to occur in the NPR-A. Required Operating Procedures H-1 and H-2 would be the primary mitigation measures in place to ensure adequate access to traditional hunting areas by the residents of Nuiqsut, Barrow, and Atqasuk in the Teshekpuk Lake area.

As stated in the evaluation for the Alternative A, residents living on the North Slope, especially those in the village of Nuiqsut, view the 1998 Northeast IAP/EIS ROD as a negotiated compromise between the Iñupiat people, the federal government, and the oil industry. Considerable changes to the decisions in the 1998 Northeast IAP/EIS ROD, without the consensus of local communities, governments, and agencies, could create an insurmountable rift between the people of the North Slope and the Federal government, especially if their Iñupiat way of life was threatened.

A.2.2.2 Evaluation of the Availability of Other Lands for Oil and Gas Exploration and Development

The NPRPA, as amended, gives the Secretary of the Interior the authority to conduct oil and gas leasing in the NPR-A. However, the law prohibited petroleum production from occurring in the NPR-A until authorized by Congress. In 1980, Congress granted that authorization and directed the Secretary of the Interior to undertake a program of competitive leasing of potential oil and gas tracts in the Reserve. The President's energy policy directs the Secretary of the Interior to "consider additional environmentally responsible oil and gas development, based on sound science and the best available technology, through further lease sales in the National Petroleum Reserve – Alaska." BLM is undertaking this Supplemental IAP/EIS to fulfill the mandates of the President's energy policy, as well as BLM's responsibilities to manage these lands under authority of the NPRPA and FLPMA and other authorities cited elsewhere in this Supplemental IAP/EIS. Alternative B would continue the authorization of oil and gas exploration or development activities in the NPR-A under performance-based stipulations and ROPs identified in **section 2.7, *Stipulations and Required Operating Procedures*** of the Supplemental IAP/EIS. Other lands managed by BLM are either too remote for economically viable oil and gas production, or have a low probability of containing sufficient quantities of oil or gas. State and Native Corporation Lands cannot be considered in a BLM plan, and under BLM policy other BLM lands outside of Alaska are not considered under the ANILCA.

A.2.2.3 Evaluation of Other Alternatives that would Reduce or Eliminate the Use, Occupancy, or Disposition of Public Lands Needed for Subsistence Purposes

Alternatives that would reduce or eliminate the use of public lands needed for subsistence include: 1) making more land in the Northeast NPR-A unavailable for oil and gas leasing, or 2) not allowing oil and gas activity to occur. However, neither of these alternatives would satisfy the underlying purpose of the IAP/EIS to make more lands available for leasing. The Secretary of the Interior has directed BLM to consider additional lands in the Northeast NPR-A to the extent it can be done in an environmentally sound manner. Reducing the number of acres available for energy development would contradict this direction, and would go against the President's stated National Energy Policy. Additionally, the 1998 Northeast IAP/EIS ROD allowed BLM to enter into contracts with several oil companies, by leasing land for oil and gas exploration. All of these leases are still in effect. **Section 2.5, *Alternatives Considered but Eliminated from Detailed Analysis*** of the Supplemental IAP/EIS discusses other alternatives that were considered, but eliminated from detailed analysis.

A.2.2.4 Findings

Alternative B would not significantly restrict subsistence use by communities in or near the planning area (Anaktuvuk Pass, Atqasuk, Barrow, Wainwright and Nuiqsut). The impacts to most subsistence resources and access to resources would be minimal, yet displacement of the Teshekpuk Lake Herd caribou could occur, and black brant populations have shown a declining trend in recent years. However, adequate stipulations and ROPs have been incorporated in Alternative B—including specific procedures for subsistence consultation with directly affected subsistence communities, requirements for extensive studies of caribou movement, and setbacks or other protective measures specific to birds—to ensure that significant restrictions to subsistence uses and needs would not occur.

A.2.3 Evaluation and Findings for Alternative C

Under Alternative C of the Supplemental IAP/EIS, all land under the stewardship of BLM within the planning area would be available for oil and gas leasing. All of the stipulations and ROPs included in Alternative B would also apply to Alternative C.

A.2.3.1 Evaluation of the Effect of Use, Occupancy, or Disposition on Subsistence Uses and Needs

The analysis of the effects of Alternative C on subsistence, presented in **section 4.5.12, *Alternative C, Subsistence***, considers the effects of non-oil and gas activities, oil and gas activities, and oil spills, and the effectiveness of the stipulations and ROPs required by BLM. The analysis concludes that Alternative C would not significantly affect primary subsistence species, access to subsistence resources, or subsistence use by the communities of Anaktuvuk Pass, Atqasuk, Barrow, Wainwright or Nuiqsut. Similarly, while all analysts feel that the impact of Alternative C would be greater than that of alternatives A or B, these impacts are still viewed as being localized, of short duration, and not significant at the population level for most species.

Analyses presented for individual subsistence species (e.g., marine mammals, land mammals, and fish) also indicate that there would not be significant impacts to these species under Alternative C. However, it is expected that impacts to birds in the vicinity of Teshekpuk Lake and throughout the northern portion of the planning area would be greater under Alternative C, particularly with respect to molting waterfowl, given the greater overall scale of the assumed development activities. Impacts to birds from disturbances could be even greater if oil and gas activities occurred in areas with high bird concentrations, with high quality habitat, or that are used by species of concern.

For caribou, it is estimated that there would be an increase in the likelihood of impacts to calving areas and migration routes leading to insect-relief habitat, as well as an increased likelihood of development occurring within insect-relief habitat. If the TLH is partially displaced from its calving area, or if caribou are impeded from reaching the calving area, recent surveys indicate that calving success would most likely be reduced. While there have been no experiments conducted with the TLH to determine whether oil development in the calving area would displace caribou or affect the productivity of the herd, caribou behavior during 1997 and 2001 suggest oil development in the TCH calving area could impact caribou.

Despite the increase in potential impacts to birds or caribou under Alternative C, most analysts indicate that the proposed stipulations and ROPs effectively mitigate any potential impacts resulting from of oil and gas activity. Therefore, the potential impacts are lessened, and would not result in population level declines.

As discussed for Alternative B, eliminating the "No Surface Activity" zone, as well as making all lands available for leasing, could result in future infrastructure such as pipelines, roads, production pads, and wells. Oil industry infrastructure on the east side of the Colville River has resulted in the nonuse of this area by the residents of Nuiqsut, who do not feel comfortable hunting near or around oil developments. If enough economically recoverable oil was discovered to warrant additional development in the Nuiqsut, Atqasuk, or Barrow traditional subsistence use area, hunters could avoid the development. The result would be an overall reduction in lands used for subsistence purposes. Effective communication and consultation by the oil industry, local communities, and BLM would be essential when and if development were to

occur in the Northeast NPR-A. Required Operating Procedures H-1 and H-2 would be the primary mitigation measures in place to ensure adequate access to traditional hunting areas by the residents of Nuiqsut, Barrow, and Atqasuk in the Teshekpuk Lake Special Area.

As stated in the evaluations for alternatives A and B, residents living on the North Slope, especially those in the village of Nuiqsut, view the 1998 Northeast IAP/EIS ROD as a negotiated compromise between the Iñupiat people, the federal government, and the oil industry. Considerable changes to the decisions in the 1998 Northeast IAP/EIS ROD without the consensus of local communities, governments, and agencies to create an insurmountable rift between the people of the North Slope and the federal government, especially if their Iñupiat way of life was threatened.

A.2.3.2 Evaluation of the Availability of Other Lands for Oil and Gas Exploration and Development

The NPRPA, as amended, gave the Secretary of the Interior the authority to conduct oil and gas leasing in the Northeast NPR-A. However, the law prohibited petroleum production from occurring in NPR-A until authorized by Congress. In 1980, Congress granted that authorization and directed the Secretary of the Interior to undertake a program of competitive leasing of potential oil and gas tracts in the Reserve. The President's energy policy directs the Secretary of the Interior to "consider additional environmentally responsible oil and gas development, based on sound science and the best available technology, through further lease sales in the National Petroleum Reserve – Alaska." BLM is undertaking this Supplemental IAP/EIS to fulfill the mandates of the President's energy policy as well as BLM's responsibilities to manage these lands under authority of the NPRPA and FLPMA and other authorities cited elsewhere in this EIS. Alternative C would continue the authorization of oil and gas exploration or development activities in the Northeast NPR-A under performance-based stipulations identified in **section 2.7, *Stipulations and Required Operating Procedures*** of the Supplemental IAP/EIS. Other lands managed by BLM are either too remote for economically viable oil and gas production, or have a low probability of containing sufficient quantities of oil or gas. State and Native Corporation Lands cannot be considered in a BLM plan, and other BLM lands outside of Alaska are not considered under the ANILCA as per BLM Policy.

A.2.3.3 Evaluation of Other Alternatives that would Reduce or Eliminate the Use, Occupancy, or Disposition of Public Lands Needed for Subsistence Purposes

Alternatives that would reduce or eliminate the use of public lands needed for subsistence include: 1) making more land in the Northeast NPR-A unavailable for oil and gas leasing, or 2) not allowing oil and gas activity to occur. However, neither of these alternatives would satisfy the underlying purpose of the IAP/EIS to make more lands available for leasing. The Secretary of the Interior has directed BLM to consider additional lands in the Northeast NPR-A to the extent it can be done in an environmentally sound manner. Reducing the number of acres available for energy development would contradict this direction, and would go against the President's stated National Energy Policy. Additionally, the 1998 Northeast IAP/EIS ROD allowed the BLM to enter into contracts with several oil companies, by leasing land for oil and gas exploration. All of these leases are still in effect. **Section 2.5, *Alternatives Considered but Eliminated from Detailed Analysis of the Supplemental IAP/EIS*** discusses other alternatives that were considered, but eliminated from detailed analysis.

A.2.3.4 Findings

Alternative C would not significantly restrict subsistence use by the communities of Anaktuvuk Pass, Atqasuk, Barrow, Wainwright and Nuiqsut. The impacts to subsistence resources and access to resources would be minimal, yet displacement of the Teshekpuk Lake Herd could occur. However, adequate stipulations and ROPs have been incorporated, including specific procedures for subsistence consultation with directly affected subsistence communities and requirements for extensive studies of caribou movement, to ensure that significant restrictions to subsistence uses and needs would not occur.

A.2.4 Evaluation and Findings for Alternative D

Alternative D of the Supplemental IAP/EIS makes approximately 4,389,000 acres or 95% of the planning area available for oil and gas leasing (approximately 389,000 more acres than under the No Action Alternative; Map 2-4). Under the Alternative D, Teshekpuk Lake (approximately 211,000 acres) would be indefinitely deferred from leasing; this deferral would prevent exploratory drilling and pipeline construction, but current leases would not be affected by the deferral. Alternative D utilizes the same performance-based stipulations and ROPs developed for alternatives B and C. In addition, four new stipulations are proposed. Three stipulations would prohibit permanent oil and gas facilities (Restricted Surface Occupancy; RSO), excluding major rights-of-way (i.e., pipelines and major roads), on approximately 373,000 acres. Exploration activities would be allowed within this RSO, including seismic exploration and exploratory drilling. Three of the new stipulations were created to protect calving, post-calving, insect-relief, and migration habitat for caribou and molting habitat for geese. The fourth stipulation establishes a maximum limit of 300 acres of permanent surface disturbance from oil and gas activities within each of seven lease tracts identified north of Teshekpuk Lake, in an attempt to minimize the amount of land disturbed by oil and gas facilities.

A.2.4.1 Evaluation of the Effect of Use, Occupancy, or Disposition on Subsistence Uses and Needs

The analysis of Alternative D on subsistence is presented in **section 4.6.12, *Alternative D, Subsistence***. This analysis considers the effects of non-oil and gas activities, the effects of oil and gas activities, the effects of oil spills, and the effectiveness of the associated stipulations and ROPs as presented by BLM. The analysis concludes that the effect of the Alternative D would be greater than that of Alternative A, and would remain localized and not significantly affect subsistence species as long as activity occurred outside of key habitat areas or migratory zones when animals were present. However, access to subsistence resources and an alteration in subsistence use patterns by the communities of Nuiqsut, Barrow, and possibly Atqasuk would likely result from future development occurring in currently used traditional harvest areas.

It is expected that impacts to terrestrial mammals and subsistence use in the vicinity of Teshekpuk Lake would be greater under Alternative D than under the No Action Alternative, particularly with respect to caribou calving and insect-relief habitat, given the additional 389,000 acres that would be available for oil and gas leasing. However, limiting the amount of acreage available to permanent oil and gas activities in the seven new lease tract areas north of Teshekpuk Lake, as well as the two no surface occupancy areas located southeast and east of Teshekpuk Lake, serve to minimize potential impacts. Additionally, the stipulations and ROPs that have been developed to protect caribou near Teshekpuk Lake, would serve to protect the resource from substantial decline at the population level (see **sections 4.6.9.1, *Terrestrial***

Mammals*, and 4.6.12.2, *Subsistence, Oil and Gas Exploration and Development Activities), and Stipulation K-5 would serve to minimize the potential displacement of caribou by requiring a 3-year study of caribou movements in the vicinity of any facility before BLM will authorize construction. Similarly, impacts to birds, especially black brant and other primary subsistence species, would be lessened by the additional stipulations proposed under Alternative D. Impacts to vegetation, fish, and other resources used for subsistence purposes are expected to be minor (see **sections 4.6.5, *Vegetation*; 4.6.7, *Fish*; and 4.6.9, *Mammals***).

The primary impact to subsistence use as a result of Alternative D is the impact to the subsistence user, and not necessarily the resource. Oil industry infrastructure on the east side of the Colville River has resulted in the nonuse of this area by the residents of Nuiqsut, who do not feel comfortable hunting near or around oil developments. If enough economically recoverable oil was discovered to warrant additional development in the Nuiqsut, Atqasuk, or Barrow traditional subsistence use areas, history has shown that hunters would avoid the development. The result would be an overall reduction in lands used for subsistence purposes. Effective communication and consultation by the oil industry, local communities, and the BLM would be essential when, and if, development were to occur in the NPR-A. Having two no surface occupancy areas, as well as limiting the number of acres available for permanent facilities north of Teshekpuk Lake helps to reduce this impact. Additionally, Required Operating Procedures H-1 and H-2, which call for additional consultation and notification by the oil companies to local communities, would help to alleviate access issues with regard to traditional hunting areas by the residents of Nuiqsut, Barrow, and Atqasuk in the Teshekpuk Lake Special Area.

A.2.4.2 Evaluation of the Availability of Other Lands for Oil and Gas Exploration and Development

The NPRPA, as amended, gave the Secretary of the Interior the authority to conduct oil and gas leasing in the Northeast NPR-A. However, the law prohibited petroleum production from occurring in NPR-A until authorized by Congress. In 1980, Congress granted that authorization and directed the Secretary of the Interior to undertake a program of competitive leasing of potential oil and gas tracts in the Reserve. The President's energy policy directs the Secretary of the Interior to "consider additional environmentally responsible oil and gas development, based on sound science and the best available technology, through further lease sales in the National Petroleum Reserve – Alaska."

BLM is undertaking this Supplemental IAP/EIS to fulfill the mandates of the President's energy policy as well as BLM's responsibilities to manage these lands under authority of the NPRPA and FLPMA and other authorities cited elsewhere in this EIS. Alternative D would continue the authorization of oil and gas exploration or development activities in the Northeast NPR-A under performance-based stipulations and ROPs identified in **section 2.7, *Stipulations and Required Operating Procedures*** of the Supplemental IAP/EIS. Other lands managed by the BLM are either too remote for economically viable oil and gas production, or have a low probability of containing sufficient quantities of oil or gas. State and Native Corporation Lands cannot be considered in a BLM plan, and other BLM lands outside of Alaska are not considered under ANILCA as per BLM Policy.

A.2.4.3 Evaluation of Other Alternatives that would Reduce or Eliminate the Use, Occupancy, or Disposition of Public Lands Needed for Subsistence Purposes

Alternatives that would reduce or eliminate the use of public lands needed for subsistence include: 1) making more land in the Northeast NPR-A unavailable for oil and gas leasing, or 2) not allowing oil and gas activity to occur. However, neither of these alternatives would satisfy the underlying purpose of the IAP/EIS to make more lands available for leasing. The Secretary of the Interior has directed BLM to consider additional lands in the Northeast NPR-A to the extent it can be done in an environmentally sound manner. Reducing the number of acres available for energy development would contradict this direction, and would go against the President's stated National Energy Policy. Additionally, the 1998 Northeast IAP/EIS ROD allowed the BLM to enter into contracts with several oil companies, by leasing land for oil and gas exploration. All of these leases are still in effect. **Section 2.5, *Alternatives Considered but Eliminated from Detailed Analysis of the Supplemental IAP/EIS*** discusses other alternatives that were considered, but eliminated from detailed analysis.

A.2.4.4 Findings

Alternative D would not significantly restrict subsistence use by the communities of Anaktuvuk Pass, Atqasuk, Barrow, Wainwright and Nuiqsut. The impacts to subsistence resources would be minimal, even though displacement of the Teshekpuk Lake Herd could occur. Impacts to the subsistence user, including access, comprise the greatest potential impact, however, adequate stipulations and ROPs have been incorporated, including the designation of RSO zones south and east of Teshekpuk Lake, the limited amount of acres available for leasing in the seven new lease tracks north of Teshekpuk Lake, specific procedures for subsistence consultation with directly affected subsistence communities, and requirements for extensive studies of caribou movement, to ensure that significant restrictions to subsistence uses and needs would not occur. While the subsistence user may be impacted by development within the planning area as a result of hunter avoidance of facilities and infrastructure, the proposed allowable use under Alternative D does not restrict or otherwise limit in any way subsistence harvesting near infrastructure or facilities.

A.2.5 Evaluation and Findings for the Cumulative Case

The goal of the cumulative analysis is to evaluate the incremental impact of the current action in conjunction with all past, present, and reasonably foreseeable future actions in or near the planning area. The cumulative analysis considers in greatest detail activities that are more certain to happen, and activities that were identified as being of great concern during scoping. Oil and gas activities considered in the analysis include past development and production, present development, reasonably foreseeable future development, and speculative development. Activities not associated with oil and gas are also considered. All reasonably foreseeable future activities that may contribute to cumulative effects are considered in this analysis.

Actions included in the cumulative analysis include, but are not limited to the following:

- Offshore exploration and development in the Beaufort and Chukchi seas;
- Currently-producing fields/developments (Prudhoe Bay, Kuparuk, Alpine, Meltwater);
- Possible future developments, including the increased likelihood of development in Northwest NPR-A;
- Additional lease sales both on State of Alaska lands and in the Northwest NPR-A;

- The continuation of exploration on current leases in the Northeast NPR-A and additional lease sales in this same area; and
- Gas Development on the North Slope.

Moreover, these actions are considered in light of the shifting environmental conditions presented by climate change.

A.2.5.1 Evaluation of the Effect of Such Use, Occupancy, or Disposition on Subsistence Uses and Needs

Section 4.7, *Effects of the Cumulative Case* of the Supplemental IAP/EIS contains a detailed description of the cumulative-case scenario, including past effects, present effects, and the future possible oil field and infrastructure development that this evaluation uses. This assessment and finding assumes that all future development in the NPR-A would be subject to the stipulations and ROPs proposed in the Supplemental IAP/EIS. The cumulative analysis expands the area of potential impact beyond the planning area, to the entire North Slope Borough. Additionally, the impacts to subsistence use of migratory species, such as waterfowl, are also discussed.

The analysis of the effects of the cumulative case on subsistence presented in **section 4.7.7.12, *Analysis of Cumulative Effects by Resources, Subsistence*** indicates that cumulative activity on the North Slope has the potential to significantly restrict subsistence use for the communities of Anaktuvuk Pass, Atqasuk, Barrow, Wainwright and, especially, Nuiqsut. Foreseeable development in the Northeast NPR-A could extend from the Colville River Delta north of Nuiqsut to an area southwest of the village, which would effectively encircle the community, making it necessary for subsistence hunters traveling in nearly every direction to pass through some kind of development on the way to subsistence harvest areas. Because Iñupiat hunters are reluctant to use firearms near oil production facilities and pipelines, there would be a perceived barrier to harvest in these areas. Subsistence users currently avoid the Kuparuk and Meltwater areas because of the physical barriers pipelines and elevated gravel roads pose to winter snowmachine travel, and have expressed concerns about hunting close to oil production and processing facilities because of perceived regulatory barriers (ENSR 2004). Additionally, many community members fear contamination of their subsistence resources by oil production facilities.

Subsistence resources also have the potential to be impacted under the cumulative case. As stated in **section *4.7.7.9***:

Cumulative effects on caribou distribution and abundance are likely to be long-term, lasting as long as the life of the oil fields. Any reduction in the calving and summer habitat use by cows and calves from future onshore leasing would represent a functional loss of habitat that could result in long-term effects on the caribou herds' productivity and abundance.

The effects of oil and gas activities in the NPR-A would be greatest on those herds that use the planning area, specifically the Teshekpuk Lake and the Western Arctic herds. Currently, the Teshekpuk Lake Herd is the primary source of caribou for the communities of Anaktuvuk Pass, Atqasuk, Barrow, Nuiqsut, and Wainwright. Any substantial decrease in the population numbers of this herd would have a substantial impact on all five communities. If the decrease occurred during times of unsuccessful bowhead whaling, the effects would be devastating for Atqasuk, Barrow, Nuiqsut, and Wainwright. The additional development pressure envisioned

by the cumulative-case scenario could exacerbate changes in abundance and productivity of caribou, and these changes could, in turn, adversely affect subsistence harvests.

Impacts to migratory waterfowl, especially brant, have the potential to negatively affect subsistence hunters in the Southwest Region of Alaska, especially in the Yukon-Kuskokwim Delta (Y-K Delta). According to the Alaska Department of Fish and Game Community Profile Database, communities in this area are some of the largest users of migratory waterfowl, especially during the springtime, with this resource comprising between 1.6% to as much as 6.2% of their annual yearly harvest, depending on the community. The analysis of impacts to migratory waterfowl indicate that while there is the potential for there to be negative effects as a result of both non-oil and gas and oil and gas activity, these effects are primarily dependent upon loss of habitat as a result of construction activity. Given the fact that brant are the primary species of concern for the Y-K Delta and comprise only one portion of their migratory bird harvest (at most 3% of total bird harvest, according to ADF&G), potential impacts as a result of this plan do not constitute a significant restriction of subsistence use for residents in that area of the state.

If a large discovery is made in the northwest or northern part of the planning area, it could make additional developments in the Northwest NPR-A or adjacent offshore areas more economically feasible, resulting in additional habitat and disturbance related impacts in the Northwest and Northeast NPR-A and in offshore areas adjacent to the Northeast and Northwest NPR-A. As development or disturbance increases, so does the potential for negative impacts to subsistence species and users. The offshore development and transport that is possible under the cumulative case could result in oil spills in the marine environment. Any oil spill that tainted, or was perceived to taint, whales or other marine mammals of importance to subsistence users would have a significant negative effect on those users. If such a spill affected migration patterns or distributions of any marine mammal used for subsistence, it would also have significant negative effect on subsistence users.

Effects on subsistence harvest patterns from natural gas development and production could occur from natural gas blowouts, noise and traffic disturbance, and construction activities under any of the alternatives. Subsistence hunters, who already tend to avoid oil field infrastructure, may be even more likely to avoid aboveground gas pipelines for fear of a blowout. Noise and disturbance activities due to the development of a gas field, especially to caribou, would be local (within 3-4 km of the pipeline corridor) but would persist for the life of the field.

From 1990 to 1997, the North Slope's permanent population grew at an annual rate of 2.7%, and Nuiqsut was the fastest growing village. For analysis purposes, however, the Supplement assumes that the population would grow for approximately the next 40 years at a rate of approximately 2% per year and then level off, with or without the development envisioned in the cumulative scenario discussed. The effects of such growth on competition for subsistence resources are difficult to predict, but it is possible that over time there would be increased competition among local subsistence users. It is unlikely that the transient workers associated with oil and gas development would add to the competition, because they are ineligible for the subsistence priority under existing Federal regulations.

The effects of global climate change on marine mammals are unclear, but may result in more ship traffic in the Beaufort over a longer ice-free season, commercial fisheries in the Chukchi and Beaufort, and displacement and distributional changes if not population changes among marine mammals. Climate change is likely to have the greatest influence on marine mammal populations in and adjacent to the planning area; however, species resilience and resilience as

well as feedback and interactions remain highly uncertain. Estimating how the incremental addition of direct human activities (disturbance, hunting and habitat alteration) remains speculative but climate change by itself is likely to have significant effects on the marine mammal community of the Beaufort and Chukchi Seas.

A.2.5.2 Evaluation of the Availability of Other Lands for Oil and Gas Exploration and Development

The NPRPA, as amended, gives the Secretary of the Interior the authority to conduct oil and gas leasing in the NPR-A. However, the law prohibited petroleum production from occurring in the NPR-A until authorized by Congress. In 1980, Congress granted that authorization and directed the Secretary of the Interior to undertake a program of competitive leasing of potential oil and gas tracts in the Reserve. The President's energy policy directs the Secretary of the Interior to "consider additional environmentally responsible oil and gas development, based on sound science and the best available technology, through further lease sales in the National Petroleum Reserve – Alaska." BLM is undertaking this Supplemental IAP/EIS to fulfill the mandates of the President's energy policy as well as BLM's responsibilities to manage these lands under authority of the NPRPA and FLPMA and other authorities cited elsewhere in this Supplemental IAP/EIS. Other lands managed by BLM are either too remote for economically viable oil and gas production, or have a low probability of containing sufficient quantities of oil or gas. State and Native Corporation Lands cannot be considered in a BLM plan, and other BLM lands outside of Alaska are not considered under the ANILCA as per BLM Policy.

A.2.5.3 Evaluation of Other Alternatives that would Reduce or Eliminate the Use, Occupancy, or Disposition of Public Lands Needed for Subsistence Purposes

Alternatives that would reduce or eliminate the use of public lands needed for subsistence include: 1) making more land in the Northeast NPR-A unavailable for oil and gas leasing, or 2) not allowing oil and gas activity to occur. However, neither of these alternatives would satisfy the underlying purpose of the IAP/EIS to make more lands available for leasing. The Secretary of the Interior has directed BLM to consider additional lands in the Northeast NPR-A to the extent it can be done in an environmentally sound manner. Reducing the number of acres available for energy development would contradict this direction, and would go against the President's stated National Energy Policy. Additionally, the 1998 Northeast IAP/EIS ROD allowed the BLM to enter into contracts with several oil companies, by leasing land for oil and gas exploration. All of these leases are still in effect. **Section 2.5, *Alternatives Considered but Eliminated from Detailed Analysis of the Supplemental IAP/EIS*** discusses other alternatives that were considered, but eliminated from detailed analysis.

A.2.5.4 Findings

The cumulative case as presented in this analysis, when taken in conjunction with all action alternatives, would result in a reasonably foreseeable and significant restriction of subsistence use for the communities of Anaktuvuk Pass, Atqasuk, Barrow, and Nuiqsut, due to a decrease in resource abundance, significant alteration in the distribution of resources, and a significant restriction on the access of subsistence users. This finding requires a positive determination pursuant to the ANILCA § 810.

The distribution of caribou populations on the North Slope has been affected by Prudhoe Bay development, and access to subsistence resources has been compromised there. Although procedures will be in place to ensure that future development affects access as little as possible,

it is still probable the total area available for subsistence purposes will be reduced. If a major marine oil spill were to occur in the future, it could significantly affect both populations and distributions of fish, and whales and other marine animals, causing significant restrictions to subsistence resources. Oil and gas infrastructure located in core caribou calving or insect-relief areas would result in the displacement, and possible reduction, of the herd. Population growth would result in a greater number of residents relying on local resources to meet their needs. These restrictions have the potential to affect Anaktuvuk Pass, Barrow, Atqasuk, and Nuiqsut.

A.3 Notice and Hearings

ANILCA § 810(a) provides that no "withdrawal, reservation, lease, permit, or other use, occupancy or disposition of the public lands which would significantly restrict subsistence uses shall be effected" until the federal agency gives the required notice and holds a hearing in accordance with ANILCA § 810(a)(1) and (2). BLM will provide notice in the Federal Register that it has made positive findings pursuant to ANILCA § 810 that the cumulative case presented in the Supplemental IAP/EIS, when taken in conjunction with all action alternatives, meets the "may significantly restrict" threshold. As a result, public hearings will be held in the potentially affected communities of Anaktuvuk Pass, Atqasuk, Nuiqsut, Wainwright and Barrow. Notice of these hearings will be in the Federal Register and by way of the local media, including the Arctic Sounder newspaper, and KBRW, the local Barrow radio station with coverage to all villages on the North Slope.

A.4 Subsistence Determinations Under the ANILCA § 810(a)(3)(A), (B), and (C)

The ANILCA § 810(a) provides that no "withdrawal, reservation, lease, permit, or other use, occupancy or disposition of the public lands which would significantly restrict subsistence uses shall be effected" until the Federal agency gives the required notice and holds a hearing in accordance with the ANILCA §810(a)(1) and (2), and makes the three determinations required by the ANILCA § 810(a)(3)(A), (B), and (C). The three determinations that must be made are: 1) that such a significant restriction of subsistence use is necessary, consistent with sound management principles for the utilization of the public lands; 2) that the proposed activity will involve the minimal amount of public lands necessary to accomplish the purposes of such use, occupancy, or other such disposition; and 3) that reasonable steps will be taken to minimize adverse impacts to subsistence uses and resources resulting from such actions [16 U.S.C. § 3120(a)(3)(A), (B), and (C)].

BLM has found in this preliminary subsistence evaluation that the cumulative case considered in this Draft Supplemental IAP/EIS may significantly restrict subsistence uses. Therefore, BLM will undertake the notice and hearing procedures required by the ANILCA § 810 (a)(1) and (2) in conjunction with release of the Draft Supplemental IAP/EIS in order to solicit public comment from the potentially affected communities and subsistence users.

The determination that the requirements of the ANILCA § 810(a)(3)(A), (B), and (C) have been met will be analyzed in the Final ANILCA § 810 Evaluation, using input from the communities in which subsistence hearings will be held.

Appendix B: Federal, State, and Local Permits and/or Approvals for Oil and Gas Exploration, Development, and Production Activities

Appendix B

FEDERAL, STATE, AND LOCAL PERMITS AND/OR APPROVALS FOR OIL AND GAS EXPLORATION, DEVELOPMENT, AND PRODUCTION ACTIVITIES

Appendix B: Federal, State, and Local Permits and/or Approvals for Oil and Gas Exploration, Development, and Production Activities

The following table summarizes permit and other requirements that must be met before oil and gas exploration or development activities may occur. Some obligations would be placed directly on the applicant. Others would be required of Federal agencies prior to granting authorizations to oil and gas companies.

Regulatory Agency	Permit/Approval Actions/Requirements
	FEDERAL
U.S. Army Corps of Engineers (USACE)	• Issues a Section 404 permit under the Federal Water Pollution Control Act of 1972, as amended (Clean Water Act; 33 USC § 1344) for discharge of dredged and fill material into waters of the U.S, including wetlands. • Issues a Section 10 permit under the Rivers and Harbors Appropriations Act of 1899 (33 USC § 403) for structures or work in, of affecting, navigable waters of the U.S. • Issues a Section 103 Ocean Dumping permit under Section 103 of the Marine Protection Research and Sanctuaries Act of 1972 (33 USC § 1413) for transport of dredged material for ocean disposal.
U.S. Environmental Protection Agency (USEPA)	• Issues a National Pollutant Discharge and Elimination System (NPDES) permit under Section 402, Federal Water Pollution Control Act of 1972, as amended (Clean Water Act; 33 USC § 1342) for discharges into waters of the U.S. • Issues an Underground Injection Control Class 1 Industrial Well permit under the Safe Drinking Water Act (42 USC §§ 300f et seq.; 40 CFR parts 144 and 146) for underground injection of Class I (industrial) waste materials. • Requires a Spill Prevention Containment and Countermeasure (SPCC) Plan under Section 311 of the Federal Water Pollution Control Act of 1972, as amended (Clean Water Act; 33 USC § 1321;40 CFR part 112) for storage of over 660 gallons of fuel in a single container or over 1,320 gallons in aggregate in tanks above ground. • Conducts a review and evaluation of the Draft and Final EIS for compliance with CEQ guidelines (40 CFR parts 1500-1508) and Section 309 of the Clean Air Act (42 USC § 7609). • Authority delegated to ADEC to issue air quality permits for facilities operating within state jurisdiction, including a Title V operating permit and a Prevention of Significant Deterioration (PSD) permit under the Clean Air Act, as amended (42 USC §§ 7401 et seq.), to address air pollutant emissions.
National Oceanic and Atmospheric Administration (NOAA) Fisheries Service (formerly National Marine Fisheries Service [NMFS])	• Provides consultation under the Endangered Species Act of 1973, Section 7(a)(2) regarding effects to threatened or endangered species. • Provides consultation under the Magnuson-Stevens Fishery Management and Conservation Act for effects on Essential Fish Habitat. • Provides consultation under the Fish and Wildlife Coordination Act regarding effects on fish and wildlife resources. • Provides consultation under the Marine Mammal Protection Act regarding effects on marine mammals. • Issues Incidental Harassment Authorization under the Marine Mammal Protection Act for incidental takes of protected marine mammals (bowhead whales and ringed seals).

Regulatory Agency	Permit/Approval Actions/Requirements
U.S. Department of the Interior, Bureau of Land Management (USDOI BLM)	• Reviews and approves Applications for Permit to Drill (including drilling plans and surface-use plans of operations) and Subsequent Well Operations as prescribed in 43 CFR part 3160, under authority of the Naval Petroleum Reserves Production Act of 1976 (42 USC §§ 6501-6508) and other federal laws, for development and production of federal leases. • Approves lease administration requirements including Unit Agreements and Plans of Development, Communitization Agreements, and Participating Area Determinations, as described in 43 CFR parts 3130 and 3180, under the Mineral Leasing Act of 1920 (30 USC §§ 181 et seq.), Federal Oil and Gas Royalty Management Act of 1982 (43 USC §§ 1701 et seq.), Naval Petroleum Reserves Production Act of 1976, Department of the Interior Appropriations Act, Fiscal Year 1981(Public Law 96-514), and other federal laws, for exploration and development of oil and gas leases. • Issues geophysical permits to conduct seismic activities as described in 43 CFR part 3150, under authority of the Mineral Leasing Act of 1920, Alaska National Interest Lands Conservation Act (16 USC §§ 3101 et seq.), Federal Land Policy and Management Act of 1976 (43 USC §§ 1701 et seq.), Naval Petroleum Reserves Production Act of 1976, and Department of the Interior Appropriations Act, Fiscal Year 1981. • Issues rights-of-way grants and temporary use permits for the construction, operation, and maintenance of pipeline, production, and related facilities under the Naval Petroleum Reserves Production Act of 1976. • Delegates authority to ADEC for review and approval of Oil Discharge Prevention and Contingency Plans and Certification of Financial Responsibility for accidental oil discharge into navigable waters under Section 1016 of the Oil Pollution Act of 1990 (OPA90; 33 USC § 2716), and Section 311(j)(5) of the Federal Water Pollution Control Act (33 USC § 1321(j)(5); 30 CFR part 254).
U.S. Fish and Wildlife Service (USFWS)	• Provides consultation under the Endangered Species Act of 1973, Section 7(a)(2) regarding effects to threatened or endangered species. • Provides consultation under the Fish and Wildlife Coordination Act regarding effects to fish and wildlife resources. • Issues a Letter of Authorization under the Marine Mammal Protection Act for incidental takes of marine mammals.
STATE	
Alaska Department of Environmental Conservation (ADEC)	• Issues a Certificate of Reasonable Assurance for discharge of dredged and fill material into U.S. waters under Section 401, Federal Water Pollution Control Act of 1972, as amended in 1977 (Clean Water Act; 33 USC § 1341); AS 46.03.020; 18 AAC chapters 15, 70, and 72. • Issues a Certificate of Reasonable Assurance/NPDES and Mixing Zone Approval for wastewater disposal into all state waters under Section 402, Federal Water Pollution Control Act of 1972, as amended (Clean Water Act; 33 USC § 1342); AS 46.03.020, .100, .110, .120, and .710; 18 AAC chapters, 10, 15, and 70, and ; § 72.500. • Issues a Class I well wastewater disposal permit for underground injection of non-domestic wastewater under AS 46.03.020, .050, and .100. • Reviews and approves all public water systems including plan review, monitoring program, and operator certification under AS 46.03.020, .050, .070, and .720, 18 AAC § 80.005. • Approves domestic wastewater collection, treatment, and disposal plans for domestic wastewaters (18 AAC chapter 72). • Approves financial responsibility for cleanup of oil spills (18 AAC chapter 75).

Regulatory Agency	Permit/Approval Actions/Requirements
ADEC (Continued)	• Reviews and approves the Oil Discharge Prevention and Contingency Plan and the Certificate of Financial Responsibility for storage or transport of oil under AS 46.04.030 and 18 AAC chapter 75. The State review applies to oil exploration and production facilities, crude oil pipelines, oil terminals, tank vessels and barges, and certain non-tank vessels. • Issues a Title V Operating Permit and a PSD permit under Clean Air Act Amendments (Title V) for air pollutant emissions from construction and operation activities (18 AAC chapter 50). • Issues solid waste disposal permit for state lands under AS 46.03.010, 020, 100, and 110; AS 46.06.080; 18 AAC § 60.005; and 200. • Reviews and approves solid waste processing and temporary storage facilities plan for handling and temporary storage of solid waste on federal and state lands under AS 46.03.005, 010, and 020; and 18 AAC § 60.430. • Approves the siting of hazardous waste management facilities.
Alaska Oil and Gas Conservation Commission (AOGCC)	• Issues a Permit to Drill under 20 AAC § 25.05. • Issues approval for annular disposal of drilling waste (20 AAC § 25,080). • Authorizes Plugging, Abandonment, and Location Clearance (20 AAC § 25.105 through 25.172). • Authorizes Production Practices (20 AAC §§ 25.200 through 25.245). • Authorizes Class II Waste Disposal and Storage (20 § AAC 25.252). • Approves Workover Operations (20 § AAC 25.280). • Reports (20 AAC §§ 25.300 through 25.320). • Authorizes Enhanced Recovery Operations under 20 AAC §§ 25.402-460.
Alaska Department of Natural Resources (ADNR)	• Conducts a Coastal Zone Consistency review and issues determination of consistency of proposed development within the coastal zone under Coastal Zone Management Act of 1972, as amended in 1976 (16 USC §§ 1451 et seq.); Alaska Coastal Management Program Act of 1977 (AS 46.40); and 6 AAC chapter 50. • Issues a Material Sales Contract for mining and purchase of gravel from state lands under AS 38.05.850; and 11 AAC §§ 71.070 and .075. • Issues Rights-of-Way (ROW) and Land Use permits for use of state land, ice road construction on state land, and state freshwater bodies under AS 38.05.850. • Issues a Temporary Water Use and Water Rights permit under AS 46.15 for water use necessary for construction and operations. • Issues pipeline ROW leases for pipeline construction and operation across state lands under AS 38.35.020. • Issues a Cultural Resources Concurrence for developments that may affect historic or archaeological sites under the National Historic Preservation Act of 1966, as amended (16 USC §§ 470 et seq.), Alaska Historic Preservation Act (AS 41.35.010 through .240). • Issues Fish Habitat Permits under AS 41.l4.84O and AS 41.l4.870 for activities within streams used by fish that agency determines could represent impediments to fish passage, or for travel in, excavation of, or culverting of anadromous fish streams.
BOROUGH	
North Slope Borough (NSB)	• Issues a Coastal Zone Consistency Determination to address project planning or development within the coastal zone under the Coastal Zone Management Act of 1972, as amended in 1976; Alaska Coastal Management Program, 1977 (AS 46.40); Borough Ordinance 90-39. • Issues Development Permits for oil and gas projects under NSB Code of Ordinance Title 19.

Appendix C: Essential Fish Habitat

Appendix C

Essential Fish Habitat Assessment

Regulatory Background

The 1996 Sustainable Fisheries Act enacted additional management measures to protect commercially harvested fish species from overfishing. Along with reauthorizing the Magnuson-Stevens Fishery Conservation and Management Act Reauthorization (16 U.S.C. 1801-1882), one of those added measures is to describe, identify, and minimize adverse effects to Essential Fish Habitat (EFH). The regulations defining EFH are in 50 CFR Part 600. EFH is defined as habitat necessary to the species for spawning, breeding, feeding, or growth to maturity (i.e. all life stages). Those habitats include: aquatic areas and their associated physical, chemical, and biological properties that are used by fish; sediment, hard bottom, and structures underlying the waters; and associated biological communities. Potentially impacting activities may have effects on essential fish habitats that are direct (e.g. physical disruption) or indirect (e.g. loss of prey species). Those effects can be site-specific, habitat-wide, cumulative, and/or synergistic.

In 2005, a Final Environmental Impact Statement (EIS) for EFH in Alaska was issued by the National Marine Fisheries Service and the North Pacific Fishery Management Council (NMFS and NPFMC 2005). This included a decision on how EFH should be identified and a current description of these habitats by species based on the preferred alternative. The only EFH designated in the Northeast NPR-A Planning area is for salmon. This includes all five species of Pacific salmon: chinook (*Oncorhynchus tshawytscha*), coho (*O. kisutch*), pink (*O. gorbuscha*), sockeye (*O. nerka*), and chum (*O. keta*).

Federal agencies are required to consult with the NOAA Fisheries Service (National Marine Fisheries Service) on activities, including non-oil and gas activities and oil and gas leasing and development that may adversely affect the essential fish habitat. This consultation should be consolidated with environmental review required by other statutes, such as the National Environmental Policy Act (50 CFR 600.920(e)).

Salmon EFH

Generally, there is little evidence of viable, self-sustaining salmon populations in the Beaufort and the northern (north of 70° N. latitude) Chukchi Sea. Present salmon "populations" have a very difficult time establishing and persisting in the Arctic, most likely because of the marginal habitats (Craig 1989a; Fechhelm and Griffiths 2001). Conclusions based on a survey of available information describing salmon stocks in the Beaufort Sea (Fechhelm and Griffiths 2001) indicate only a few isolated spawning stocks of chum and pink salmon that might occur in the region, primarily the Sagavanirktok and Colville rivers. Small runs of pink and chum salmon have been noted in the Colville River (Bendock 1979b, McElderry and Craig 1981) and in recent years these species have been taken in the Colville and Itkillik rivers as part of the fall subsistence fishery (George 2004). However, catches in scientific sampling and in the subsistence fishery are extremely low (Pedersen and Shishido 1988 *in* Craig 1989b; Moulton 1994, 1995, 1996b, 1997) and no known spawning sites have been identified for these species. Chinook, coho, and sockeye salmon are even rarer than pink and chum salmon in the region. The salmon populations in and adjacent to the Planning Area can be considered marginal.

The preferred alternative selected in the NMFS and NPFMC EIS (2005) determines that:

> "For salmon FMP (Fishery Management Plan) species, the analysis is broken into three parts: marine, nearshore, and freshwater. Marine and nearshore salmon EFH is generally described to include all marine waters from the mean higher tide line to the limits of the EEZ (Exclusive Economic Zone) since science

> recognizes that salmon are 1) distributed throughout all marine waters during late juvenile and adult life stages and 2) found nearshore and along coastal migration corridors as early juvenile life stages out-migrate and adult life stages return to and from freshwater areas, respectively. Freshwater areas used by egg, larvae, and returning adult salmon will be analyzed as those areas indexed in ADF&G's *Catalogue of Waters Important for the Spawning,* Appendix D Final EFH EIS – April 2005 D-48 *Rearing, or Migration of Anadromous Fishes* (ADF&G 1998a), specifically Pacific salmon species. Freshwater salmon systems are generally defined as those areas above mean higher tide to the upper limits of those freshwater systems supporting salmon and may include contiguous wetland areas, such as those areas hydrologically connected to the main water source via access channels to an adjacent river, stream, lake, pond, etc." (page D-47).

Although the EIS identifies the 1998 version of ADF&G's *Catalogue of Waters Important for the Spawning*, there is more current information regarding the distribution of anadromous fish in Alaska, available on the worldwide web (ADFG 2005; Johnson et al. 2004). This updated version is utilized for the purpose of this analysis (April 10, 2007).
In the planning area, the Colville River (330-00-10700), Ublutuoch River (330-00-10840-2017), Fish Creek (330-00-10840), Judy Creek (330-00-10840-2043), and Ikpikpuk River (330-00-10900) meet this criterion. A brief description of habitats utilized by salmon at various life stages follows. More details on habitat in the planning area is discussed in section 3.3.5 Fish.

Freshwater overwintering habitat, including spawning gravel that does not freeze and kill spawned fish eggs, is extremely limited in the northeast Chukchi Sea coast area and probably is the largest controlling factor limiting the viability of northern Chukchi Sea salmon stocks at present (Craig 1989a; Fechhelm and Griffiths 2001). Most benthic invertebrates, such as insects living on streambeds and insects and zooplankton living in the water column, are freshwater prey for one or another salmon species.

For salmon, freshwater spawning areas are also the egg and larvae habitat for up to 11 months after spawning. Juveniles of pink and chum salmon, the most common and most adapted salmon to the northeastern Chukchi Sea environment, do not require juvenile freshwater rearing habitat because the young hatch in early spring and migrate soon after to saltwater. Coho, sockeye, and king salmon require year-round juvenile rearing habitat for 1 to 3 years. Sockeye typically require freshwater lake rearing habitat for up to 2 years.

The nearshore (estuarine) zone is used primarily by juvenile salmon smolt during physiological adaptation from the freshwater to the saltwater environment. This outmigration takes place from the time the ice moves out through August. Feeding during this time, especially in the first few days, is thought to be especially critical to survival. Thus, prey and prey habitat are an important part of this particular habitat. Additionally, adults returning to spawn will transit the estuarine zone and may wait there while their osmoregulatory system adapts from saltwater to freshwater. Individual fish probably take only a few days to a week to transit this estuarine area.

The marine juvenile and adult stages are the principal growth periods of salmon and can last from 1 to 6 years. During this period, prey and prey habitat are the most critical components of the marine essential fish habitat. Prey commonly consists of animals near the water surface (epipelagic zooplankton), particularly copepods. Chinook salmon and larger sockeye, coho, and chum salmon also consume fish. There appears to be very limited use of the northern Chukchi Sea or Beaufort Sea for these stages.

Besides redefining the way that EFH is identified in Alaska, the NMFS and NPFMC EIS (2005) also established an approach to identify Habitat Areas of Particular Concern (HPACs) within EFH. This designation for particularly critical habitats already existed, but the EIS officially adopted a new approach for HPACs. The preferred alternative stated:

> "...the existing HAPC identifications would be rescinded, and the Council would adopt an approach that would allow specific sites within EFH, selected to address a particular problem, to be identified as HAPCs in the future." (ROD page 2).

In general, this was a shift from viewing HPACs as broad habitat types to a site-based approach in order to better accomplish management objectives.

Ecologically, the Beaufort Sea and northern Chukchi Sea can be considered a population sink for salmon rather than a source, drawing excess salmon from other areas rather than producing a surplus that colonizes new areas. The scarcity of salmon documented in the Beaufort Sea and the fact that it is close to the northern boundary of the geographic distribution support the population sink theory.

Recent occurrences raise the question of whether significant temperature increases in the Arctic caused by climate change could lead to a significant change in salmon distribution in the future. Higher salmon catches off of Point Barrow in recent years (personal communication with Craig George, 2006) indicates an increase in the number of salmon moving through the northern Chukchi Sea. Additionally, local residents living near the Beaufort Sea have noticed increases in salmon occurrences over the past 10 to 20 years (Pedersen 1995; Napageak 1996). Several published journal notes of first records of salmon in the Canadian Beaufort Sea that occurred in the past decade (Babaluk et al. 2000) also indicate the increasing, but still rare, incidence of salmon in the Beaufort Sea.

Action, Potential Effects on EFH, and Mitigation

The actions covered by this EFH analysis are thoroughly described within chapter 2 of this IAP/EIS. In general, the focus is on oil and gas exploration and development activities, including associated infrastructure, various scenarios of development, and oil spills. However, non-oil and gas activities are also considered.

Potential effects on salmon EFH from oil and gas activities (and non oil and gas activities) in the NE NPR-A Planning Area are the same as those described for other fish habitat in chapter 4, environmental consequences. Most alternatives provide similar guidelines for protection, whether in the form of Lease Stipulations or ROPs. The primary difference among alternatives is the level of anticipated oil and gas development. Therefore, the potential for impacts to EFH is relative for each Alternative. The greatest potential for impacts exists under Alternative C, with increasingly less risk under Alternatives D, B, and A, respectively.

Through numerous Lease Stipulations and ROPs the various alternatives attempt to mitigate potential impacts to fish and their habitat. These are summarized in Table 2-2. Specific application of these stipulations and ROPs to protecting fish habitat is described in sections 4.3.7 (Alternative A), 4.4.7 (Alternative B), 4.5.7 (Alternative C), and 4.6.7 (Alternative D). Proper implementation of these protective measures should ensure that impacts to EFH are minimal.

EFH Finding

Based on protective measures (stipulations and ROPs) and the low numbers of salmon utilizing the systems, oil and gas exploration and development in Northeast NPR-A is not expected to impact salmon or their habitat and is assigned the EFH determination: *May affect, not likely to adversely affect.*

Appendix D: Alternative A Stipulations

APPENDIX D

ALTERNATIVE A STIPULATIONS

APPENDIX D

ALTERNATIVE A STIPULATIONS

Definitions

The following definitions apply to the following stipulations:

Active Floodplain: The lowland and relatively flat areas adjoining inland and coastal waters including flood-prone areas of offshore islands, including at a minimum that area subject to a 1 percent or greater chance of flooding in any given year (also referred to as the 100-year or base floodplain).

Body of Water or Waterbody: A lake, river, stream, creek, or pond that holds water throughout the summer and supports a minimum of aquatic life.

Permanent Oil and Gas Facilities: Production facilities, pipelines, roads, airstrips, production pads, docks and other bottom-founded structures, seawater-treatment plants, and any other structures associated with an oil and gas operation that occupies land for more than one winter season. It does not include material sites or seasonal facilities such as ice roads and ice pads.

The following stipulations are based on existing policies and laws, and on knowledge of the resources present in the planning area and current industry practices. All stipulations will attach to all activities, including oil and gas leases issued in the planning area. All oil and gas activity permits issued subsequent to leasing shall comply with the appropriate lease stipulations specific to the activity under review. All permits issued in conjunction with other authorized activities (e.g., seismic operation, commercial guiding) within the planning area shall comply with the appropriate stipulations specific to the activity under review.

Additional site-specific stipulations may be added by the Authorized Officer (AO) as determined necessary by further NEPA analysis and as developed through consultation with other Federal, State, and NSB regulatory and resource agencies. Other Federal, State, and NSB permits (e.g., NPDES, Clean Water Act [CWA] Section 404) also may be required by law or regulation for an oil and gas project to proceed. A list of permits/approval commonly required by law or regulation for an oil and gas project is provided in Appendix B of this Supplement. Additional permits not listed in Appendix B may be required. Specific State permits are required where the state has primary authority, under Federal or Sate law or regulation, for enforcement of the provision in question. Specific permits issued by Federal agencies other than BLM could include permit conditions that are more stringent than those presented below.

Exception Clause: In the event that an exception to a lease or permit stipulation is requested, and before an exception may be granted, the Authorized Officer (AO) shall find that implementation of the stipulation is:

1. a) technically not feasible, or

b) economically prohibitive, or
c) an environmentally preferable alternative is available, and

2. the alternative means proposed by the lessee fully satisfies the objective(s) of the stipulation.

In addition, prior to the consideration or granting of an exception to a lease or permit stipulation, all conditions and/or consultation requirements specific to a stipulation must be met. The AO shall consult with appropriate federal, state, and North Slope Borough (NSB) regulatory and resource agencies before an exception may be granted, except in the case of an emergency. The AO's power to grant stipulation exceptions is limited to those subjects, uses, and permits over which the Bureau of Land Management (BLM) has authority. Exceptions may be granted in emergencies involving human health and safety.

Stipulations

See pages II-4 through II-17 of the Final 1998 Northeast NPR-A IAP/EIS (Figures II.B.1 through II.B.14) for maps of the Land use Emphasis Areas (LUEAs) referred to in these stipulations.

Waste Prevention, Handling, and Disposal and Spills:

1. To prevent and minimize present and future pollution, management decisions affecting waste generation shall be addressed in the following order of priority:

-Prevention and Reduction
-Recycling
-Treatment
-Disposal

a. Lessees shall prepare a waste-management plan approved by the AO, in consultation with appropriate federal, state, and NSB regulatory and resource agencies, to achieve specific waste-reduction and prevention goals for all phases of exploration and development (including activities conducted by contractors). The plan shall identify all waste streams that will be produced during each operation by type, volume, and toxicity and the method of disposal. For each waste stream, the lessee/operator shall describe what actions will be taken to minimize the volume. The plan should include activities that will integrate pollution prevention concepts into purchasing, inventory, shipping/receiving, operations maintenance, training, accounting, and design. The goal of the plan shall be continuous environmental improvement and achievement of reduction goals developed through the planning process. Lessees shall develop schedules for implementation and review to meet reduction and prevention goals, designate accountable personnel to carry out action items, and specify budget line items for plan elements. Lessees shall provide the AO with an annual waste-management report.

b. Lessees shall implement a hazardous-materials tracking system to ensure proper use, storage, and management of materials being used within industrial processes. The use of chlorinated solvents is prohibited.

c. Lessees shall conduct annual environmental compliance audits.

2. Attracting wildlife to food and garbage is prohibited. All feasible precautions shall be taken to avoid attracting wildlife to food and garbage. A current list of approved precautions, specific to type of permitted use, can be obtained from the AO. Lessees and permitted users shall have a written procedure to ensure that the handling and disposal of putrescible waste will be accomplished in a manner to prevent the attraction of wildlife.

3. Burial of garbage is prohibited. All putrescible waste shall be incinerated or composted through an AO-approved system, unless otherwise authorized by the AO. All solid waste, including incinerator ash, shall be removed from BLM lands and disposed of in an approved waste-disposal facility in accordance with U.S. Environmental Protection Agency (USEPA) and State of Alaska Department of Environmental Conservation (ADEC) regulations and procedures. Burial of human waste is prohibited except as authorized by the AO.

4. Except as specifically provided, all pumpable solid, liquid, and sludge waste shall be disposed of by injection in accordance with USEPA, ADEC, and the Alaska Oil and Gas Conservation Commission regulations and procedures. On-pad temporary muds and cuttings storage will be allowed as necessary to facilitate annular injection and/or backhaul operations.

5. Wastewater disposal:

   a. Unless authorized by the National Pollution Discharge Elimination System (NPDES) or state permit, disposal of domestic wastewater into bodies of freshwater, including wetlands, is prohibited.

   b. Surface discharge of reserve-pit fluids is prohibited unless authorized by applicable NPDES, ADEC, and NSB permits and approved by the AO.

   c. Disposal of produced waters in upland areas, including wetlands, will be by subsurface-disposal techniques. The AO, in consultation with the ADEC and USEPA, may permit alternate disposal methods, if the lessee demonstrates that subsurface disposal is not feasible or prudent.

   d. Discharge of produced waters into open or ice-covered marine waters less than 33 feet (10 meters) in depth is prohibited. The AO in consultation with ADEC and USEPA may approve discharges into waters greater than 33 feet (10 meters) in depth based on a case-by-case review of environmental factors and consistency with the conditions of a NPDES permit.

   e. Alternate disposal methods will require an NPDES permit certified by the State.

6. Areas of operation shall be left clean of all debris.

7. All spills shall be cleaned up immediately and to the satisfaction of the AO and all agencies with regulatory authority over spills, including the USEPA, ADEC, and the U.S. Coast Guard.

8. Notice of any spill shall be given to the AO as soon as possible. Other federal, state, and NSB entities shall be notified as required by law.

9. For oil and gas-related activities, a Hazardous Materials Emergency Contingency Plan shall be prepared and implemented prior to transportation, storage, or use of fuel. The plan shall include a set of procedures to ensure prompt response, notification, and cleanup in the event of a hazardous substance spill or threat of a release. Procedures applicable to fuel handling (associated with transportation vehicles) may consist of Best Management Practices (BMPs) approved by the AO. The plan shall include a list of resources available for response (e.g., heavy-equipment operators, spill-cleanup materials or companies), and names and phone numbers of federal, state, and NSB contacts. Other federal and state regulations may apply and require additional planning requirements. All staff shall be instructed regarding these procedures.

10. Oil-spill-cleanup materials (absorbents, containment devices, etc.) shall be stored at all fueling points and vehicle-maintenance areas and be carried by field crews on all overland moves, seismic work trains, and similar overland moves by heavy equipment.

11. Lessees shall provide refresher spill-response training to NSB and local community spill-response teams on a yearly basis.

12. Lessees shall plan and conduct a major spill-response field-deployment drill annually.

13. Prior to production and as required by law, lessees shall develop spill prevention and response contingency plans and participate in development and maintenance of the *North Slope Subarea Contingency Plan for Oil and Hazardous Substances Discharges/Releases* for the National Petroleum Reserve – Alaska operating area. Planning shall include development and funding of detailed (e.g., 1:26,000 scale) environmental sensitivity index maps for the lessee's operating area and areas outside the lessee's operating area that could be affected by their activities. (The specific area to be mapped shall be defined in the lease agreement and approved by the AO in consultation with appropriate resource agencies.) Maps shall be completed in paper copy and geographic information system format in conformance with the latest version of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration's *Environmental Sensitivity Index Guidelines*. Draft and final products shall be peer reviewed and approved by the AO in consultation with appropriate federal, state, and NSB resource and regulatory agencies.

14. Except during overland moves and seismic operations (see Stipulation 24[m]), fuel, other petroleum products, and other liquid chemicals designated by the AO, whether in excess of 660 gallons in a single tank or in excess of 1,320 gallons in multiple containers, shall be stored within an impermeable lined and diked area capable of containing 110 percent of the stored volume. The liner material shall be compatible with the stored product and capable of remaining impermeable during typical weather extremes expected throughout the storage period. Permanent fueling stations shall be lined or have impermeable protection to prevent fuel migration to the environment due to overfills and spills. The storage area shall be located at least 500 feet from any waterbody with the exception of small caches (up to 210 gallons) for motor boats, float planes, and ski planes.

15. Fuels shall not be stored on the active floodplain of any waterbody. Although fuels may be off-loaded from aircraft on ice, fuels shall not be stored on lake or river ice.

16. Refueling of equipment within 500 feet of the highest high water mark of any waterbody is prohibited with the exception of refueling motor boats, float planes, and ski planes. See Stipulation 24[n] for restrictions related to overland moves and seismic operations.

17. All fuel containers, including barrels and propane tanks, shall be marked with the responsible party's name, product type, and year filled or purchased.

Ice Roads and Water Use:

18. The location of winter ice roads shall be offset from year to year to minimize vegetative impacts. The offset shall be greater than or equal to the width of the road.

19. Compaction of snow cover or snow removal from fish-bearing waterbodies shall be prohibited except at approved ice-road crossings.

20. Water withdrawal from rivers and streams during winter is prohibited. Water withdrawal is prohibited during winter from lakes less than 7 feet (2.1 meters) deep if they are interconnected with or subject to seasonal flooding by a fish-bearing stream. Water may be withdrawn from isolated lakes that are less than 7 feet (2.1 meters) deep that lack connection to or are not subject to seasonal flooding by a fish-bearing stream. After consultation with the appropriate federal, state, and NSB regulatory and resource agencies, the AO may authorize withdrawals from any lake less than 7 feet (2.1 meters) deep, if the proponent demonstrates that no fish exist in the lake.

    Generally, water withdrawal drawdown during winter from lakes 7 feet (2.1 meters) deep or deeper shall be limited to 15 percent of the estimated free-water volume (i.e., excluding the ice). After consultation with the appropriate federal, state, and NSB regulatory and resource agencies, the AO may authorize drawdown exceeding 15 percent from a lake greater than 7 feet (2.1 meters) deep, if the proponent of the additional drawdown demonstrates that no fish exist in the lake. Operators are encouraged to use new ice-road and ice-pad construction methods, such as using aggregate "chips" shaved from frozen lakes, to decrease water demands, construction time, and impact on fisheries.

21. The AO, in consultation with appropriate Federal, state, and NSB regulatory and resource agencies, may allow water extraction from any lake used by molting geese, if it is determined that the withdrawal is consistent with Stipulation 20 and will not adversely affect identified goose-feeding habitat along lakeshore margins. An analysis/demonstration of the hydrologic functions of the lake(s) under review may be required of the lessee by the AO prior to approval of the withdrawal.

22. Except for approved crossings, alteration of the banks of a waterway is prohibited. Waterways include natural features with sufficient water to create riparian (willow) habitat such as rivers, streams, deep and shallow lakes, tundra ponds, and shallow water tracks. Clearing of willows along the riparian zone is prohibited. Movement of equipment through willow stands shall be avoided whenever possible.

Overland Moves and Seismic Work:

23. Seismic work is prohibited within 1,200 feet of any known, long-term cabin or campsite, identified by the AO, without the written permission of the AO. The AO's decision will be informed by the consultation process described in Stipulation 61.

24. The following restrictions apply to overland moves, seismic work, and any similar use of heavy equipment (other than actual excavations as part of construction) on unroaded surfaces during the winter season:

a. Because polar bears are known to den predominantly within 25 miles of the coast, operators shall consult with the U.S. Fish and Wildlife Service (USFWS) prior to initiating activities in such habitat between October 30 and April 15. Activities are prohibited within 1 mile of known or observed polar bear dens; obtain locations from the USFWS, (907) 786-3800. Operators are encouraged to apply for a letter of authorization from the USFWS to conduct activities in polar bear denning areas.

b. Motorized ground-vehicle use will be minimized within the Colville River Raptor, Passerine, and Moose Area LUEA from April 15 through August 5, with the exception that use will be minimized in the vicinity of gyrfalcon nests beginning March 15. Such use will remain ½ mile away from known raptor-nesting sites, unless authorized by the AO. The BLM shall consult with the USFWS to plan travel routes to minimize disturbance to raptors.

c. Crossing of waterway courses shall be made using a low-angle approach to avoid disruption of the natural stream or lake bank. Except at approved crossings, operators are encouraged to travel a minimum of 100 feet from overwintering fish streams and lakes.

d. If snow ramps or snow bridges are used at water crossings for bank protection, the ramps and bridges shall be substantially free of soil and/or debris. Snow bridges shall be removed or breached immediately after use or before spring breakup.

e. To avoid additional freeze down of deep-water pools harboring overwintering fish, waterways shall be crossed at shallow riffles from point bar to point bar whenever possible.

f. On-the-ground activities shall use low-ground-pressure vehicles such as Rolligons, ARDCO, Trackmaster, Nodwell, or similar types of vehicles. A current list of approved vehicles can be obtained from the AO. Limited use of tractors equipped with wide tracks or "shoes" will be allowed to pull trailers.

g. Bulldozing of tundra, trails, or seismic lines is prohibited. This stipulation, however, does not prohibit the clearing of drifted snow along a trail, seismic line, or in a camp, to the extent that the tundra mat is not disturbed. Snow may be cleared from a waterbody ice surface to prepare an aircraft runway, if approved by the AO in consultation with appropriate federal, state, and NSB regulatory and resource agencies.

h. To reduce the possibility of ruts, vehicles shall avoid using the same trails for multiple trips unless necessitated by serious safety or superseding environmental concern. This provision does not apply to ice roads (see Stipulation 18 above).

i. Ground operations are to begin only after the seasonal frost in the tundra and underlying mineral soils has reached a depth of 12 inches, and the average snow cover is 6 inches deep. The exact date shall be determined by the AO.

j. Ground operations shall cease when the spring melt of snow begins; approximately May 5 in the foothills area where elevations exceed 300 feet, and approximately May 15 in the northern coastal areas. The exact date will be determined by the AO.

k. Seismic activities and overland moves within the Goose Molting Land Use Emphasis Area (LUEA) and the Teshekpuk Lake Caribou Habitat LUEA from May 1 through September 30 are prohibited. (Note that this overrides language in Stipulation 24[j].)

l. To prevent surface disturbance to tundra and other vegetation, tracked vehicles will not execute tight turns by locking one track.

m. Operators shall use best available technology (e.g., self-contained containment systems) or other appropriate spill containment measures, approved by the AO, to prevent fuel migration from fuel or chemical storage areas to the environment due to overfills and spills.

n. Refueling of equipment is prohibited within the active floodplain of any waterbody.

Oil and Gas Exploratory Drilling:

25. From May 1 through September 30, exploratory drilling other than from production pads is prohibited in the Special Caribou Stipulations Area.

26. Exploratory drilling is prohibited within 1,200 feet of any known, long-term cabin or campsite, identified by the AO, without written permission of the AO. The AO's decision will be informed by the consultation process described in Stipulation 61.

27. Permanent or gravel oil and gas facilities including roads shall not be constructed during the exploration phase of oil and gas development.

28. Exploratory drilling in river, stream, and lake beds, as determined by the highest high water mark, is prohibited. Exceptions to this stipulation may be authorized by the AO in cases of shallow lakes which freeze to the bottom, do not support significant fish or bird populations, and are hydrologically isolated. Further, such an exception may be granted only if it is environmentally preferable to maintaining the restriction.

Facility Design and Construction:

29. At least 3 years prior to approval of any development plan for leases within the Special Caribou Stipulations Area, the lessee shall design and implement a study of caribou movement, including historical information regarding the distribution and range use of the Teshekpuk Lake Caribou Herd, as well as maps of caribou trails within the area. Study data may be gathered concurrent with approved seismic and exploration activity. The study design shall be approved by the AO in consultation with the Research and Monitoring Team. The study will include a minimum of 3 years of data to assist in providing the information necessary to determine facility design and location, including pipelines, which will be part of the development plan. Lessees may submit individual plans or they may combine with other

lessees in the area to do a joint study. Total study funding by all lessees will not exceed $500,000.[1]

30. Causeways and docks are prohibited in river mouths or deltas. Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas, except as provided in the paragraphs below.

The BLM discourages the use of continuous-fill causeways. Environmentally preferred alternatives for field development include the use of onshore directional drilling, elevated structures, or buried pipelines. Approved causeways shall be designed, sited, and constructed to prevent significant changes to near shore oceanographic circulation patterns and water-quality characteristics (e.g., salinity, temperature, suspended sediments) that result in exceedences of water-quality criteria, and must maintain free passage of marine and anadromous fish.

Causeways, docks, artificial gravel islands, and bottom-founded structures may be permitted if the AO, in consultation with appropriate federal, state, and NSB regulatory and resource agencies, determines that a causeway or other structure is necessary for field development, and that no feasible and prudent alternative exists. A monitoring program may be required to address the objectives of water quality and free passage of fish. Additional mitigation shall be required where significant deviation from these objectives occurs.

31. Permanent oil and gas surface occupancy, including but not limited to permanent oil and gas facilities, pads, rigs, platforms, gravel roads, airstrips, pipelines, gravel or other material extraction sites, and exploration and delineation drilling facilities are prohibited in the Teshekpuk Lake Surface Protection Area (specifically, T. 13 N., Rs. 3-7 W., U.M.; Secs. 1-6, 8-16, 21-25, 36, T. 13 N., R. 8 W., U.M.; T. 14 N., Rs. 1-2 E. and Rs. 1-8 W., U.M.; Secs. 1-2, 11-14, T. 14 N., R. 9 W., U.M.; T. 15 N., Rs. 2-8 W., U.M.; Secs. 1-3, 7-30, 35-36, T. 15 N., R. 9 W., U.M.; T. 16 N., Rs. 2-8 W., U.M.; Secs. 1-6, 8-17, 21-27, 34-36, T. 16 N., R. 9 W., U.M.; T. 17 N., Rs. 1-9 W., U.M.; and T. 18 N., Rs. 2-8 W., U.M.). No exceptions will be granted to this stipulation.

32. Lessees shall use maximum economically feasible extended-reach drilling for production drilling to minimize the number of pads and the network of roads between pads. New developments shall share facilities with existing development when prudent and technically feasible. All oil and gas facilities, except airstrips, docks, and seawater-treatment plants, will be collocated with drill pads. If possible, airstrips will be integrated with roads. Given the paucity of gravel sites in the Planning Area and the cost of transporting gravel from outside the Planning Area, lessees are encouraged to implement gravel-reduction technologies e.g., insulated or pile-supported pads.

33. Within the Special Caribou Stipulations Area, lessees shall orient linear corridors when laying out oil field developments to address migration and corralling effects and to avoid loops of road and/or pipeline that connect facilities.

[1] Due to the limited portion of the caribou LUEA that is available for oil and gas leasing, it is projected that the costs associated with such a study would be considerably less than the maximum identified.

34. Lessees shall separate elevated pipelines from roads by a minimum of 500 feet, if feasible. Separating roads from pipelines may not be feasible within narrow land corridors between lakes and where pipe and road converge on a drill pad.

35. To minimize delay or deflection of caribou movements, lessees shall place pipeline on the appropriate side of the road as determined by the AO (depending on general caribou movements in the area).

36. In the Special Caribou Stipulations Area and where facilities or terrain may funnel caribou movement, ramps over pipelines, buried pipe, or pipe buried under the road may be required by the AO after consultation with appropriate federal, state, and NSB regulatory and resource agencies.

37. Aboveground pipelines shall be elevated at least 5 feet, as measured from the ground to the bottom of the pipe, except where the pipeline intersects a road, pad, or a ramp installed to facilitate wildlife passage and subsistence passage and access. The AO, in consultation with appropriate federal, state, and NSB regulatory and resource agencies, may make an exception if no feasible and prudent means exists to meet the requirement.

38. All crude oil, produced water, seawater, and natural gas pipelines shall be constructed to accommodate the best available technology for detecting corrosion or mechanical defects during routine structural integrity inspections.

39. Permanent oil and gas facilities, including roads, airstrips, and pipelines, are prohibited within and adjacent to the waterbodies listed below at the distances identified to protect fish and raptor habitat, cultural and paleontological resources, and subsistence and other resource values. Setbacks include the bed of the waterbody and are measured from the bank's highest high water mark.

    a. **Ikpikpuk River**: a ½-mile setback from the bank of the Ikpikpuk River within the Planning Area (fish, raptors, subsistence, cultural, and paleontological resources).

    b. **Miguakiak River:** a ½-mile setback from each bank of the Miguakiak River (fish and subsistence resources).

    c. **Teshekpuk Lake:** a ½-mile setback from the bank and around the perimeter of Teshekpuk Lake (fish and subsistence resources).

    d. **Fish Creek:** 1) a 3-mile setback from each bank of Fish Creek downstream from Sec. 31, T. 11 N., R. 1 E.; 2) a ½-mile setback from each bank of Fish Creek in and upstream from Sec. 31, T. 11 N., R. 1 E., U.M. (fish and subsistence resources).

    e. **Judy Creek:** a ½-mile setback from each bank of Judy Creek extending from the mouth to the confluence of an unnamed tributary in Sec. 8, T. 8 N., R. 2 W., U.M. (fish and subsistence resources).

    f. **Colville River:** a 1-mile setback from the western bluff (or bank if there is no bluff) of the Colville River extending the length of the river as described in the Colville River Raptor, Passerine, and Moose LUEA. This restriction does not apply within 1½ mile of the Umiat airstrip (fish, raptor, passerine, moose, paleontological, subsistence, scenic, and recreational resources).

g. **Deep Water Lakes:** a ¼-mile setback around the perimeter of any fish-bearing lake within or partially within the deep lake zone (fish resources). If the fish-bearing status of the waterbody is unknown, the burden is on the lessee to demonstrate whether fish are present.

h. **Kikiakrorak River:** a 1-mile setback from each bluff (or bank if there is no bluff) of the Kikiakrorak River downstream from T. 2 N., R. 4 W., U.M. (raptor, passerine, and moose resources).

i. **Kogosukruk River:** a 1-mile setback from each bluff (or bank if there is no bluff) of the Kogosukruk River (including the four tributaries off the southern bank) downstream from T. 2 N., R. 3 W., U.M. (raptor, passerine, and moose resources).

On a case-by-case basis, essential pipeline and road crossings will be permitted, in consultation with appropriate federal, state, and NSB regulatory and resource agencies, through setback areas in those instances where no other suitable sites are available. Stream crossings will be sited perpendicular to the main channel flow; lake crossings will be at the narrowest point. Pipeline and road crossings are prohibited in the setback around Teshekpuk Lake, with no exceptions. Road crossings are prohibited in the setback adjacent to the Colville River with no exceptions.

40. Gravel mining sites required for development activities will be restricted to the minimum necessary to develop the field efficiently and with minimal environmental damage. Where feasible and prudent, gravel sites shall be designed and constructed to function as water reservoirs for future use. Gravel mine sites are prohibited within the active floodplain of a river, stream, or lake unless the AO, in consultation with appropriate federal, state, and NSB regulatory and resource agencies, determines that there is no feasible and prudent alternative or that a floodplain site would enhance fish and wildlife habitat after mining operations are completed and the site is closed.

Mine site development and rehabilitation within a floodplain shall follow the procedures outlined in McLean (1993), *North Slope Gravel Pit Performance Guidelines*, Alaska Department of Fish and Game (ADFG), Habitat and Restoration Division, Technical Report 93-9.

41. For those waterbodies not listed in Stipulation 39, permanent oil and gas facilities, including roads, airstrips, and pipelines, are prohibited upon or within 500 feet as measured from the highest high water mark of the active floodplain. Essential pipeline and road crossings will be permitted on a case-by-case basis.

42. Bridges, rather than culverts, shall be used for any allowed road crossings on all major rivers, including those waterbodies listed in Stipulation 39 or identified by the AO in consultation with appropriate federal, state, and NSB regulatory and resource agencies, to reduce the potential of ice-jam flooding and erosion. When necessary on smaller streams, culverts shall be large enough to avoid restriction of fish passage or adversely affecting natural stream flow.

43. The natural drainage pattern will be identified prior to and maintained during and after construction. All permanent structures constructed adjacent to a body of water, such as approved road and pipeline crossings, shall be sited and designed to limit erosion from flooding and wave action (e.g., through use of slope-protection measures). Cross-drainage

structures will be sited, maintained, and properly abandoned to prevent impoundments or alteration of local or areawide hydrology. Gravel structures shall be designed and sited to minimize the length that is perpendicular to sheet flow.

44. Dewatering during construction shall be conducted using BMPs. A current list of BMPs will be available from the AO. Examples include the use of splash plates, dewatering points, natural filtration through vegetation, and dewatering during low-water period.

45. No surface structures, except essential transportation crossings, are allowed within the Pik Dunes LUEA.

46. Lessees shall minimize the impact of industrial development on key wetlands. Key wetlands are those wetlands that are important to fish, waterfowl, and shorebirds because of their high value or scarcity in the region. Lessees shall identify on a map or aerial photograph the largest surface area, including future expansion areas, within which a facility is to be sited or an activity is to occur. The AO will consult with federal, state, and NSB regulatory and resource agencies to identify key wetlands and work with lessees during the development of operating plans. To minimize impact, the lessee shall avoid siting facilities in the identified wetlands, unless no feasible and prudent alternative exists. Key wetland types include but are not limited to fish-bearing lakes and streams, riparian shrub, and the following classes described by Bergman et al. (1977): shallow and deep-*Arctophila* ponds, deep-open lakes, basin-complex wetlands, and coastal wetlands.

47. Permanent oil and gas facilities are prohibited within 1 mile of known long-term cabins or long-term campsites, identified by the AO, except that pipelines and roads are allowed up to ¼ mile from such cabins or campsites. The AO's decision will be informed by the consultation process described in Stipulation 61.

48. Permanent roads (i.e., gravel, sand) connecting to a road system or docks outside the Planning Area are prohibited, and no exceptions may be granted. Permanent roads necessary to connect pads within independent, remote oil fields are allowed but they must be designed and constructed to create minimal environmental impacts. Roads connecting production sites between separate oil fields may be considered if road-connected operations are environmentally preferable to independent, consolidated operations that each include airstrip, housing, production, and support facilities. This exception will only be granted following consultations with appropriate federal, state, and NSB regulatory and resources agencies, and the appropriate level of National Environment Policy Act (NEPA) review.

Ground Transportation:

49. The following ground-traffic restrictions apply to permanent roads (as authorized in Stipulation 48 above) in the Special Caribou Stipulations Area:

   a. From May 20 through June 20:

      (1) Traffic speed will not exceed 15 miles per hour.
      (2) Traffic will be minimized (a reasonable target would be four convoy round-trips per day between facilities). Nonessential operations requiring vehicles shall be suspended during this time period.

   b. From May 20 through August 1:

(1) Caribou movement will be monitored.

(2) Based on this monitoring, traffic will cease when a crossing by 10 or more caribou appears to be imminent.

c. From May 20 through August 20:

(1) Convoying will be used to minimize the number of disturbances due to road traffic.

(2) Personnel will be bussed between work sites and other facilities to minimize the number of vehicles on the road.

50. Major stockpiling of equipment, materials, and supplies for oil and gas activities in the Special Caribou Stipulations Area shall occur prior to or after the period May 20 through June 20 to minimize road traffic during that period.

51. Chasing wildlife with ground vehicles is prohibited.

Air Traffic:

(Note: The BLM's authority to restrict air traffic is limited to those activities associated with use authorization on BLM-administered lands.)

52. Use of aircraft larger than a Twin Otter for authorized activities in the Planning Area, including oil and gas activities, from May 20 through August 20 within the Teshekpuk Lake Caribou LUEA is prohibited, except in cases of emergency.

53. Helicopter overflights for BLM-permitted activities shall be suspended in the Goose Molting LUEA from June 15 through August 20.

54. Fixed-wing aircraft traffic takeoffs and landing for BLM-permitted activities in the Planning Area shall be limited to an average of one round-trip flight a day from May 20 through June 20 at aircraft facilities in the Teshekpuk Lake Caribou Habitat LUEA. Within the Goose Molting LUEA, fixed-wing aircraft use for such activities shall be restricted from June 15 to August 20 to flight corridors and frequencies established by BLM in consultation with the appropriate federal, state, and NSB regulatory and resource agencies.

55. Aircraft shall maintain an altitude of at least 1,000 feet above ground level (AGL) (except for takeoffs and landings) over caribou winter ranges from October 1 through May 15 and 2,000 feet AGL over the Teshekpuk Lake Caribou Habitat LUEA from May 16 through July 31, unless doing so would endanger human life or violate safe flying practices.

56. Aircraft shall maintain an altitude of at least 1,500 feet AGL when within ½ mile of cliffs identified as raptor nesting sites from April 15 through August 5, unless doing so would endanger human life or violate safe flying practices. Aircraft shall maintain an altitude of 1,500 feet AGL when within ½ mile of known gyrfalcon nest sites from March 15 to April 15. Permittees shall obtain information from the BLM necessary to plan flight routes near gyrfalcon nests.

57. Hazing of wildlife by aircraft is prohibited.

Oil Field Abandonment:

58. Upon field abandonment or expiration of a lease or oil and gas-related permit, all facilities shall be removed and sites rehabilitated to the satisfaction of the AO, in consultation with appropriate federal, state, and NSB regulatory and resource agencies. The AO may determine that it is in the best interest of the public to retain some or all of the facilities. Lessees shall comply with all exploration and development bonding required by law and regulation (43 CFR § 3154.1 and 3134.1). No exceptions shall be granted to this provision.

Subsistence:

59. During exploration, development, and production, the lessee shall develop and implement a plan, approved by the AO in consultation with the Research and Monitoring Team and the Subsistence Advisory Panel, to monitor the effects of activities on subsistence. The lessee shall provide biannual reports to the BLM, the Research and Monitoring Team, and the Subsistence Advisory Panel.

60. Lessees shall not unreasonably restrict access by subsistence users in oil field development areas.

    a. Lessees shall establish procedures for entrance to facilities, the use of roads, and firearms discharge. These procedures shall be developed in consultation with affected local communities, NSB, and the Subsistence Advisory Panel and be approved by the AO. In cases where the lessee and the Panel disagree, the AO will determine the appropriate procedure.

    b. Lessees shall develop and distribute information about how to conduct subsistence activities in development areas safely (so equipment is not damaged and people are not endangered) to the communities through public meetings, newsletters, radio, and signs in both English and Iñupiaq.

61. Exploration and development and production operations shall be conducted in a manner that prevents unreasonable conflicts between the oil and gas industry and subsistence activities.

    Prior to submitting an exploration plan or development and production plan (including associated oil-spill contingency plans) to the BLM, the lessee shall consult with potentially affected subsistence communities (e.g., Barrow, Nuiqsut, Atqasuk, or Anaktuvuk Pass), NSB, and the Subsistence Advisory Panel to discuss potential conflicts with the siting, timing, and methods of proposed operations and safeguards or mitigating measures that could be implemented by the operator to prevent unreasonable conflicts. Through this consultation, the lessee shall make every reasonable effort, including such mechanisms as a conflict avoidance agreement, to ensure that exploration, development, and production activities are compatible with subsistence hunting, fishing, and other subsistence activities and will not result in unreasonable interference with subsistence harvests.

    A discussion of resolutions reached during this consultation process, specific conflict avoidance agreement(s), and plans for continued consultation shall be included in the permit application, exploration plan, or the development and production plan. In particular, the lessee shall show in the plan how its activities, in combination with other activities in the area, will be scheduled and located to prevent unreasonable conflicts with subsistence

activities. Lessees also shall include a discussion of multiple or simultaneous operations, such as exploration and delineation well drilling and seismic activities, that can be expected to occur during operations to more accurately assess the potential for any cumulative effects. Communities, individuals, and other entities who were involved in the consultation shall be identified in the application or plan. The AO shall send a copy of the exploration plan or development and production plan (including associated oil-spill-contingency plans) to the potentially affected communities, the NSB, and the Subsistence Advisory Panel at the time they are submitted to the BLM to allow concurrent review and comment as part of the plan approval process.

In the event no agreement is reached between the parties, the AO shall consult with representatives from the subsistence communities, Subsistence Advisory Panel, NSB, and the lessee(s) to specifically address the conflict and attempt to resolve the issues before making a final determination on the adequacy of the measures taken to prevent unreasonable conflicts with subsistence harvests.

The lessee shall notify the AO of all concerns expressed by subsistence users during operations and of steps taken to address such concerns. Lease-related use will be restricted, when the AO determines it is necessary to prevent unreasonable conflicts with local subsistence hunting, fishing, and other subsistence activities.

In enforcing this stipulation, the AO will work with other agencies and the public to assure that potential conflicts are identified and efforts are taken to avoid these conflicts, e.g., planning seismic operations to avoid traditional land use sites and allotments. These efforts may include seasonal drilling restrictions, seismic restrictions, and directional drilling requirements or use of other technologies deemed appropriate by the AO.

The consultation process described in this stipulation will also be required of applicants for geophysical (i.e., seismic) permits to address potential conflicts with the setback requirements for cabins and campsites described in Stipulation 23. This consultation will help provide information to the AO on the advisability of modifying or waiving the restriction on seismic activity identified in Stipulation 23.

62. The following subsistence, wildlife habitat, and traditional/cultural land use areas are of significant concern to local communities and will be given special consideration during the consultation process outlined in Stipulation 61:

a. **Long-term cabins and campsites:** a 2-mile zone around the cabins and campsites.

b. **Ikpikpuk River:** a 2-mile zone from the east bank of the river.

c. **Miguakiak River:** a 3-mile zone from each bank of the river.

d. **Fish Creek:** 1) a 3-mile zone from each bank downstream from Sec. 31, T. 11 N., R. 1 E., U.M.; 2) a 2-mile zone from each bank in and upstream from Sec. 31, T. 11 N., R. 1 E., U.M.

e. **Judy Creek:** a 2-mile zone from each bank of the creek.

f. **Kogosukruk River:** a 2-mile zone from each bluff (or bank if there is no bluff) of the river (including the four tributaries off the southern bank) downstream from T. 2 N., R. 3 W., U.M.

g. **Kikiakrorak River:** a 2-mile zone from each bluff (or bank if there is no bluff) of the river downstream from T. 2 N., R. 4 W., U.M.

h. **Colville River:** a 2-mile zone from the west bluff (or bank if there is no bluff) extending the length of river in the Colville River Raptor, Passerine, and Moose LUEA.

In addition, a permittee or lessee engaged in oil and gas-related activity shall consult with the BLM, USFWS, ADFG, and the NSB regarding wildlife concerns prior to submitting a geophysical (i.e., seismic) permit, exploration plan, or development and production plan involving activity within the 2-mile zones around the Kogosukruk (and its tributaries), Kikiakrorak, and Colville rivers described above. In the event that the permittee or lessee and the agencies are unable to reach agreement on steps necessary to address wildlife concerns, the AO will consult with the other agencies and the permittee or lessee before making a determination on the adequacy of the measures taken to prevent conflicts with wildlife.

Orientation Program:

63. The lessee shall include in any application for permit to drill a proposed orientation program for all personnel involved in exploration or development and production activities (including personnel of lessee's agents, contractors, and subcontractors) for review and approval by the AO. The program shall be designed in sufficient detail to inform individuals working on the project of specific types of environmental, social, and cultural concerns that relate to the Planning Area. The program shall address the importance of not disturbing archaeological and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals and provide guidance on how to avoid disturbance. Guidance shall include the production and distribution of information cards on endangered and/or threatened species in the Planning Area. The program shall be designed to increase sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which personnel will be operating. The orientation program shall also include information concerning avoidance of conflicts with subsistence, commercial fishing activities, and pertinent mitigation.

The program shall be attended at least once a year by all personnel involved in on-site exploration or development and production activities (including personnel of lessee's agents, contractors, and subcontractors) and all supervisory and managerial personnel involved in lease activities of the lessee and its agents, contractors, and subcontractors. Individual training is transferable from one facility to another except for elements of the training specific to a particular site.

Lessees shall maintain a record onsite of all personnel who attend the program for so long as the site is active, though not to exceed the five most recent years of operations. This record shall include the name and dates(s) of attendance of each attendee.

Traditional Land Use Sites:

64. Lessees shall conduct an inventory of known traditional land use sites prior to any field activity. This inventory will be compiled from sites listed in the most current Traditional Land Use Inventory available from the NSB's Iñupiat History, Language, and Cultural Commission, and shall be approved by the AO. Based on this inventory, the lessee shall develop a plan to avoid these sites and mitigate any potential damage that could result from field activities. The plan shall indicate how access to the site by local subsistence users will be provided. Lessees shall submit copies of the plan to BLM and the Subsistence Advisory Panel with any application for permit to drill.

Other Activities:

65. It is the responsibility of the authorized user to ensure that all individuals brought to the Planning Area under its auspices adhere to these stipulations. Authorized users of the Planning Area shall provide all employees, contractors, subcontractors, and clients with a briefing regarding stipulations applicable to the lease and/or permit. A copy of applicable stipulations will be posted in a conspicuous place in each work site and campsite.

66. The authorized user shall protect all survey monuments and be responsible for survey costs if remonumentation is required as a result of the user's actions.

67. All activities shall be conducted to avoid or minimize disturbance to vegetation.

68. The BLM, through the AO, reserves the right to impose closure of any area to operators in periods when fire danger or other dangers to natural resources are severe.

69. The authorized user shall be financially responsible for any damage done by a wildfire caused by its operations.

70. Construction camps are prohibited on frozen lakes and river ice. Siting of construction camps on river sand and gravel bars is allowed and, where feasible, encouraged. Where leveling of trailers or modules is required and the surface has a vegetative mat, leveling shall be accomplished through blocking rather than use of a bulldozer.

71. Use of pesticides without the specific authority of the AO is prohibited.

72. The feeding of wildlife by authorized users is prohibited.

73. Hunting and trapping by lessee's employees, agents, and contractors are prohibited when persons are on "work status." Work status is defined as the period during which an individual is under the control and supervision of an employer. Work status is terminated when the individual's shift ends and he/she returns to a public airport (e.g., Fairbanks, Barrow, Nuiqsut, or Deadhorse). Use of lessee facilities, equipment, or transport for personnel access or aid in hunting and trapping is prohibited.

74. Lessees shall conduct a cultural and paleontological resources survey prior to any ground-disturbing activity. Upon finding any potential cultural or paleontological resource, the lessee or their designated representative shall notify the AO and suspend all operations in the immediate area of such discovery until written authorization to proceed is issued by the AO.

75. Petroleum exploration and production activities are prohibited within ½ mile of occupied grizzly bear dens, identified by the ADFG, unless alternative mitigation measures are approved by the AO in consultation with appropriate federal, state, and NSB regulatory and resource agencies.

76. Oil and gas lessees and their contractors and subcontractors will prepare and implement bear-interaction plans to minimize conflicts between bears and humans. These plans shall include measures to: (a) minimize attraction of bears to the drill sites; (b) organize layout of buildings and work areas to minimize human/bear interactions; (c) warn personnel of bears near or on drill sites and identify proper procedures to be followed; (d) if authorized, deter bears from the drill site; (e) provide contingencies in the event bears do not leave the site or cannot be deterred by authorized personnel; (f) discuss proper storage and disposal of materials that may be toxic to bears; and (g) provide a systematic record of bears on the site and in the immediate area. The lessees shall develop educational programs and camp layout and management plans as they prepare their lease operations plans. These plans shall be developed in consultation with appropriate federal, state, and NSB regulatory and resource agencies and submitted to the AO.

77. Operators are encouraged to apply for a letter of authorization from the USFWS to conduct activities in polar bear denning areas.

78. Permanent structures, other than oil and gas facilities, are prohibited within 100 feet of the highest high water mark of the nearest body of water.

79. Lessees shall use smokeless flares for handling routine conditions and use auxiliary smokeless flares for planned events that exceed the capacity of routine flares. Lessees shall use flares that meet the federal New Source Performance design standards listed in 40 CFR § 60.18.

Appendix E: Alternatives B and C Stipulations and Required Operating Procedures

APPENDIX E

ALTERNATIVES B AND C STIPULATIONS AND REQUIRED OPERATING PROCEDURES

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ALTERNATIVES B AND C STIPULATIONS AND REQUIRED OPERATING PROCEDURES

Definitions

The following definitions in the context of this document, apply to general lease stipulations and site specific stipulations (K-Stipulations) and Required Operating Procedures (ROPs):

Active Floodplain: The lowland and relatively flat areas adjoining inland and coastal waters, including the flood-prone areas of offshore islands, composing, at a minimum, that area subject to a 1 percent or greater chance of flooding in any given year (also referred to as the 100-year or base floodplain).

Authorized Officer (AO): A position of authority for approval of various activities through delegation from the Secretary of the Interior. Currently, the designated AOs in the State of Alaska for leasing, surface use, and permitting are 1) State Director, 2) Manager of the Fairbanks District Office in Fairbanks, and 3) Deputy State Director of the Division of Energy and Solid Minerals.

Body of Water or Waterbody: A lake, river, stream, creek, or pond that holds water throughout the summer and supports a minimum of aquatic life.

Consultation: Consultation, as it is referenced in the stipulations, does not infer formal consultation as required under other legal mandates such as "Section 7 Consultation" under the ESA. Rather, consultation implies that the BLM or the Lessee/Permittee will contact other agencies or entities to either inform them of potential actions and/or to seek input on noted topics. This includes informal contacts, and written, electronic, and/or verbal communication.

General Lease Stipulation: Mitigation developed through BLM planning process/NEPA process that is specifically attached to any lease issued in the Northeast Planning Area.

Restricted Surface Occupancy*:* No permanent oil and gas facilities, except pipelines and in some cases roads, will be allowed.

Permanent Oil and Gas Facilities: Production facilities, pipelines, roads, airstrips, production pads, docks and other bottom-founded structures, seawater-treatment plants, and other structures associated with an oil and gas operation that occupy land for more than one winter season. Material sites, exploration wellheads, and seasonal facilities such as ice roads and ice pads are excluded, even when the pads are designed for use in successive winters.

Required Operating Procedure: Mitigation developed through the BLM planning process/NEPA process that is not attached to the oil and gas lease but is required, implemented and enforced at the operational level for all authorized (not just oil and gas) activities.

Compliance with Required Operating Procedures: Required Operating Procedures were developed with various mechanisms in place to ensure compliance. These mechanisms include the following:

1) Some ROPs are pre-application requirements; therefore compliance will precede approval of the proposed activity. For example, ROP H-1 (a) requires consultation with affected communities prior to submission of an application for relevant activities within the Northeast Planning Area. If consultation has not taken place, the application will be rejected or will be considered incomplete until such time that the consultation has occurred.

2) Other ROPs are required design features, and would have to be incorporated into the applicant's proposal. As an integral part of the proposal and the authorization, the requirement does not need to be stipulated to be enforceable. For example, a minimum pipeline height of 7 feet for above ground pipelines is a required design of any approved above ground pipeline (ROP E-7). Since the authorization (a ROW in this case) authorizes a pipeline with a minimum height of 7 feet, anything less (unless specifically approved through additional NEPA analysis and the permit) is not in compliance and enforcement actions may be taken even if the permit does not specify a minimum of 7 feet.

3) Other ROPs will become conditions of approval on post oil and gas lease land use authorizations and they would be enforceable. For example ROP C-1 prohibits heavy equipment used for cross-country moves within ½ mile of occupied grizzly bear dens.

Site Specific Lease Stipulation (K-Stipulations): A mitigation measure developed through the BLM planning process/NEPA process attached only to leases issued within spatially defined areas in the Northeast Planning Area (see maps 2-2, 2-3, and 2-4).

Applicability of Requirements/Standards

All surface disturbing activities such as exploratory drilling, road/pipeline construction, seismic acquisition, and overland moves require additional authorization(s) issued subsequent to leasing. The stipulations and ROPs require that certain protections of resources and uses be achieved. Requirements and standards listed with the stipulations and ROPs represent BLM's current understanding of how lessees/permittees would achieve the objectives of the stipulation or ROP.

A lessee/permittee may propose a deviation from the requirements/standards of stipulations and ROPs as part of an authorization application. Prior to approving an alternative procedure as part of the authorization, BLM's staff would analyze the proposal and determine if the proposal incorporating the alternative procedure would achieve the objectives of the stipulations and ROPs. If the BLM determines that the alternative procedure proposed by the applicant would meet the stipulation's or ROP's objective, BLM could approve the alternative procedure.

If BLM determines that the alternative procedure proposed by the applicant is unlikely to meet the objectives of a stipulation or ROP, the AO may allow a deviation from the objectives and requirement/standard in a new decision document supported by additional NEPA analysis.

BLM could independently require different actions than those listed under requirements/standards. If, after experience or additional study, BLM concludes that a requirement/standard is not achieving or is unlikely to achieve the protective objective when applied to a specific future on-the-ground action or would not do so as well as the use of recently proven technology or techniques, BLM could at the permitting stage and under the terms of the stipulation or ROP, impose other restrictions to meet the objective.

Stipulations and Required Operating Procedures

Waste Prevention, Handling, Disposal, Spills and Public Safety:

A-1 Required Operating Procedure
Objective: Protect the health and safety of oil field workers and the general public by avoiding the disposal of solid waste and garbage near areas of human activity.
Requirement/Standard: Areas of operation shall be left clean of all debris.

A-2 Required Operating Procedure
Objective: Minimize impacts on the environment from non-hazardous waste generation. Encourage continuous environmental improvement. Protect the health and safety of oil field workers and the general public. Avoid human-caused changes in predator populations.
Requirement/Standard: Lessees/permittees shall prepare and implement a comprehensive waste management plan for all phases of exploration and development, including seismic activities. The plan shall be submitted to the AO for approval, in consultation with federal, state, and NSB regulatory and resource agencies, as appropriate (based on agency legal authority and jurisdictional responsibility), as part of a plan of operations or other similar permit application. Management decisions affecting waste generation shall be addressed in the following order of priority: 1) Prevention and reduction, 2) recycling, 3) treatment, and 4) disposal. The plan shall consider and take into account the following requirements:

a. Methods to avoid attracting wildlife to food and garbage. All feasible precautions shall be taken to avoid attracting wildlife to food and garbage. (A list of approved precautions, specific to the type of permitted use, can be obtained from the AO.)

b. Disposal of putrescible waste. Requirements prohibit the burial of garbage. Lessees and permitted users shall have a written procedure to ensure that the handling and disposal of putrescible waste will be accomplished in a manner that prevents the attraction of wildlife. All putrescible waste shall be incinerated, backhauled, or composted in a manner approved by the AO. All solid waste, including incinerator ash, shall be disposed of in an approved waste-disposal facility in accordance with USEPA and ADEC regulations and procedures. The burial of human waste is prohibited except as authorized by the AO.

c. Disposal of pumpable waste products. Except as specifically provided, the BLM requires that all pumpable solid, liquid, and sludge waste be disposed of by injection in accordance with USEPA, ADEC, and the Alaska Oil and Gas Conservation Commission regulations and procedures. On-pad temporary muds and cuttings storage, as approved by ADEC, will be allowed as necessary to facilitate annular injection and/or backhaul operations.

d. Disposal of wastewater and domestic wastewater. The BLM prohibits wastewater discharges or disposal of domestic wastewater into bodies of fresh, estuarine, and marine water, including wetlands, unless authorized by the NPDES or state permit.

A-3 Required Operating Procedure
Objective: Minimize pollution through effective hazardous-materials contingency planning.
Requirement/Standard: For oil- and gas-related activities, a Hazardous Materials Emergency Contingency Plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances. The plan shall include a set of procedures to ensure prompt response, notification, and cleanup in the event of a hazardous substance spill or threat of a release. Procedures applicable to fuel and hazardous substances handling (associated with transportation vehicles) may consist of Best Management Practices (BMPs) if approved by the AO. The plan shall include a list of resources available for response (e.g., heavy-equipment

operators, spill-cleanup materials or companies), and names and phone numbers of federal, state, and NSB contacts. Other federal and state regulations may apply and require additional planning requirements. All staff shall be instructed regarding these procedures.

A-4 Required Operating Procedure

Objective: Minimize the impact of contaminants on fish, wildlife, and the environment, including wetlands, marshes and marine waters, as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and subsistence activities. Protect public health and safety.

Requirement/Standard: Before initiating any oil and gas or related activity or operation, including field research/surveys and/or seismic operations, lessees/permittees shall develop a comprehensive spill prevention and response contingency plan per 40 CFR § 112 (Oil Pollution Act). The plan shall consider and take into account the following requirements:

a. On-site Clean-up Materials. Sufficient oil-spill-cleanup materials (absorbents, containment devices, etc...) shall be stored at all fueling points and vehicle-maintenance areas and shall be carried by field crews on all overland moves, seismic work trains, and similar overland moves by heavy equipment.

b. Storage Containers. Fuel and other petroleum products and other liquid chemicals shall be stored in proper containers at approved locations. Except during overland moves and seismic operations, fuel, other petroleum products, and other liquid chemicals designated by the AO in excess of 1,320 gallons in storage capacity shall be stored within an impermeable lined and diked area or within approved alternate storage containers, such as over packs, capable of containing 110 percent of the stored volume.

c. Liner Materials. Liner material shall be compatible with the stored product and capable of remaining impermeable during typical weather extremes expected throughout the storage period.

d. Permanent Fueling Stations. Permanent fueling stations shall be lined or have impermeable protection to prevent fuel migration to the environment from overfills and spills.

e. Proper Identification of Containers. All fuel containers, including barrels and propane tanks, shall be marked with the responsible party's name, product type, and year filled or purchased.

f. Notice of Reportable Spills. Notice of any reportable spill (as required by 40 CFR § 300.125 and 18 AAC § 75.300) shall be given to the AO as soon as possible, but no later than 24 hours after occurrence.

g. Identification of Oil Pans *("duck ponds")*. All oil pans shall be marked with the responsible party's name.

A-5 Required Operating Procedure

Objective: Minimize the impact of contaminants from refueling operations on fish, wildlife and the environment.

Requirement/Standard: Refueling of equipment within 500 feet of the active flood plain of any fish-bearing water body and 100 feet of non-fish-bearing water bodies is prohibited. Small caches (up to 210 gallons) for motorboats, float planes, ski planes, and small equipment, e.g. portable generators and water pumps, will be permitted. The AO may allow storage and operations at areas closer than the stated distances if properly designed to account for local hydrologic conditions.

A-6 Required Operating Procedure

Objective: Minimize the impact on fish, wildlife, and the environment from contaminants associated with the exploratory drilling process.

Requirement/Standard: Surface discharge of reserve-pit fluids is prohibited unless authorized by applicable NPDES, ADEC, and NSB permits (as appropriate) and approved by the AO.

A-7 Required Operating Procedure
Objective: Minimize the impacts to the environment of disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment.
Requirement/Standard: Procedures for the disposal of produced fluids shall meet the following requirements:
a. In upland areas, including wetlands, disposal will be by subsurface-disposal techniques. The AO may permit alternate disposal methods if the lessee demonstrates that subsurface disposal is not feasible or prudent and the alternative method will not result in adverse environmental effects.
b. In marine waters, approval of discharges by the AO will be based on a case-by-case review of environmental factors and consistency with the conditions of an NPDES permit. Discharge of produced fluids will be prohibited at locations where currents and water depths, in combination with other conditions, are not adequate to prevent impacts to known biologically sensitive areas. Alternate disposal methods will require an NPDES permit certified by the state.

A-8 Required Operating Procedure
Objective: Minimize conflicts resulting from interaction between humans and bears during leasing and associated activities.
Requirement: Oil and gas lessees and their contractors and subcontractors will, as a part of preparation of lease operation planning, prepare and implement bear-interaction plans to minimize conflicts between bears and humans. These plans shall include measures to:
a. Minimize attraction of bears to the drill sites.
b. Organize layout of buildings and work areas to minimize human/bear interactions.
c. Warn personnel of bears near or on drill sites and identify proper procedures to be followed.
d. Establish procedures, if authorized, to discourage bears from approaching the drill site.
e. Provide contingencies in the event bears do not leave the site or cannot be discouraged by authorized personnel.
f. Discuss proper storage and disposal of materials that may be toxic to bears.
g. Provide a systematic record of bears on the site and in the immediate area.

Water Use for Permitted Activities:

B-1 Required Operating Procedure
Objective: Maintain populations of, and adequate habitat for, fish and invertebrates.
Requirement/Standard: Water withdrawal from rivers and streams during winter is prohibited.

B-2 Required Operating Procedure
Objective: Maintain natural hydrologic regimes in soils surrounding lakes and ponds, and maintain populations of, and adequate habitat for, fish and invertebrates, and waterfowl.
Requirement/Standard: Water withdrawal from lakes may be authorized on a site-specific basis depending on lake size, water volume, and depth, and fish population and species diversification. Water withdrawal requirements specify:
a. Lakes that are ≥7 feet with sensitive fish (any fish except ninespine stickleback or Alaska blackfish), water available for withdrawal is limited to 15% of calculated volume deeper than 7 feet; lakes that are between 5 and 7 feet with sensitive fish, water available for withdrawal would be calculated on a case by case basis.

b. Lakes that are ≥5 feet with only non-sensitive fish (i.e., ninespine stickleback or Alaska blackfish), water is available for withdrawal is limited to 30% of calculated volume deeper than 5 feet.
c. Any lake with no fish present, regardless of depth, water available for withdrawal is up to 100% as specified within the permit.
d. A water-monitoring plan may be required to assess draw down and water quality changes before, during, and after pumping any fish-bearing lake or lake of special concern.
e. The removal of naturally grounded ice may be authorized from lakes and shallow rivers on a site-specific basis depending upon its size, water volume, and depth, and fish population and species diversification.
f. Removed ice aggregate shall be included in the 15 percent or 30 percent withdrawal limits—whichever is the appropriate case—unless otherwise approved.
g. Any water intake structures in fish bearing or non-fish bearing waters shall be designed, operated, and maintained to prevent fish entrapment, entrainment, or injury. Note: All water withdrawal equipment must be equipped and must utilize fish screening devices approved by the Alaska Department of Natural Resources (ADNR).
h. Compaction of snow cover or snow removal from fish-bearing water bodies shall be prohibited except at approved ice road crossings, water pumping stations on lakes, or areas of grounded ice.

The following lease stipulations and ROPs apply to overland moves, seismic work, and any similar cross-country vehicle use of heavy equipment on non-roaded surfaces during the winter season. These restrictions do not apply to the use of such equipment on ice roads after they are constructed.

Winter Overland Moves and Seismic Work:

C-1 Required Operating Procedure
Objective: Protect grizzly bear, polar bear, and marine mammal denning and/or birthing locations.
Requirement/Standard:
a. Cross-country use of heavy equipment and seismic activities is prohibited within ½ mile of occupied grizzly bear dens identified by the ADFG unless alternative protective measures are approved by the AO in consultation with the ADFG.
b. Cross-country use of heavy equipment and seismic activities is prohibited within 1 mile of known or observed polar bear dens or seal birthing lairs. Operators shall consult with the USFWS and/or NOAA Fisheries, as appropriate, before initiating activities in coastal habitat between October 30 and April 15.

C-2 Required Operating Procedure
Objective: Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.
Requirement/Standard:
a. Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect the tundra. Ground operations shall cease when the spring snowmelt begins (approximately May 5 in the foothills area where elevations reach or exceed 500 feet and approximately May 15 in the northern coastal areas). The exact dates will be determined by the AO.
b. Only low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. A list of approved vehicles can be obtained from the AO. Limited use of tractors equipped with wide tracks or "shoes" will be allowed to pull trailers, sleighs or other equipment with

approved undercarriage. Note: This provision does not include the use of heavy equipment such as front-end loaders and similar equipment required during ice road construction.
c. Bulldozing of tundra mat and vegetation, trails, or seismic lines is prohibited; however, on existing trails, seismic lines or camps, clearing of drifted snow is allowed to the extent that the tundra mat is not disturbed.
d. To reduce the possibility of ruts, vehicles shall avoid using the same trails for multiple trips unless necessitated by serious safety or superseding environmental concern. This provision does not apply to hardened snow trails for use by low-ground-pressure vehicles such as Rolligons.
e. The location of winter ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation. Offsets may be required to avoid using the same route or track in the subsequent year.

C-3 Required Operating Procedure
Objective: Maintain natural spring runoff patterns, avoid flooding, prevent streambed sedimentation, protect water quality and protect stream banks.
Requirement/Standard: Crossing of waterway courses shall be made using a low-angle approach. Snow and ice bridges shall be removed, breached, or slotted before spring breakup. Ramps and bridges shall be substantially free of soil and debris.

C-4 Required Operating Procedure
Objective: Avoid additional freeze-down of deep-water pools harboring over-wintering fish and invertebrates used by fish.
Requirement/Standard: Travel up and down streambeds is prohibited unless it can be demonstrated that there will be no additional impacts from such travel to over-wintering fish or the invertebrates they rely on. Rivers and streams shall be crossed at shallow riffles from point bar to point bar whenever possible.

Oil and Gas Exploratory Drilling:

D-1 Lease Stipulation
Objectives: Protect fish-bearing rivers, streams, and lakes from blowouts and minimize alteration of riparian habitat.
Requirement/Standard: Exploratory drilling is prohibited in rivers and streams, as determined by the active floodplain, and fish-bearing lakes, except where the lessee can demonstrate on a site-specific basis that impacts would be minimal, or it is determined that there is no feasible or prudent alternative.

D-2 Lease Stipulation
Objective: Minimize surface impacts from exploratory drilling.
Requirement/Standard: Exploratory drilling shall be limited to temporary facilities such as ice pads, ice roads, and ice airstrips, unless the lessee demonstrates that construction of permanent facilities such as gravel airstrips, storage pads, and connecting roads is environmentally preferable or necessary to carry out exploration more economically.

Facility Design and Construction:

E-1 Required Operating Procedure
Objective: Protect subsistence use and access to traditional subsistence hunting and fishing areas and minimize the impact of oil and gas activities on air, land, water, fish and wildlife resources.
Requirement/Standard: All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and to protect subsistence use and access to traditional subsistence hunting and fishing areas. Subject to approval by the AO, the construction, operation and maintenance of oil field roads is the responsibility of the lessee. Note: This provision does not apply to intercommunity or other permanent roads constructed with public funds for general transportation purposes. This preserves the opportunity to plan, design and construct public transportation systems to meet the economic, transportation, and public health and safety needs of the State of Alaska and/or communities within the National Petroleum Reserve - Alaska.

E-2 Lease Stipulation
Objective: Protect fish-bearing water bodies, water quality, and aquatic habitats.
Requirement/Standard: The design and location of permanent oil and gas facilities within 500 feet of fish-bearing or 100 feet of non-fish-bearing water bodies will only be approved on a case by case basis if the lessee can demonstrate that impacts to fish, water quality, and aquatic and riparian habitats are minimal. Note: Also refer to Area-Specific Stipulations and ROPs for Rivers Area (*Lease Stipulation K-1*) and Deep Water Lakes (*Lease Stipulation K-2*).

E-3 Lease Stipulation
Objective: Maintain free passage of marine and anadromous fish and protect subsistence use and access to traditional subsistence hunting and fishing.
Requirement/Standard: Causeways and docks are prohibited in river mouths or deltas. Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas. Causeways, docks, artificial islands, and bottom-founded structures shall be designed to ensure free passage of marine and anadromous fish and to prevent significant changes to nearshore oceanographic circulation patterns and water quality characteristics. A monitoring program may be required to address the objectives of water quality and free passage of fish.

E-4 Required Operating Procedure
Objective: Minimize the potential for pipeline leaks, the resulting environmental damage and industrial accidents.
Requirement/Standard: All pipelines shall be designed, constructed, and operated under an AO-approved Quality Assurance/Quality Control plan that is specific to the product transported.

E-5 Required Operating Procedure
Objective: Minimize impacts of the development footprint.
Requirement/Standard: Facilities shall be designed and located to minimize the development footprint to the maximum extent practicable considering environmental, economic, safety, and social impacts. Note: Where aircraft traffic is a concern, consideration shall be given to balancing gravel pad size and available supply storage capacity with potential reductions in the use of aircraft to support oil and gas operations.

E-6 Required Operating Procedure
Objective: Reduce the potential for ice-jam flooding, impacts to wetlands and floodplains, erosion, alteration of natural drainage patterns, and restriction of fish passage.
Requirement/Standard: Stream and marsh crossings shall be designed and constructed to ensure free passage of fish, maintain natural drainage, and minimize adverse effects to natural stream flow. Note: Bridges, rather than culverts, are the preferred method for crossing rivers. When necessary, culverts can be constructed on smaller streams, if they are large enough to avoid restricting fish passage or adversely affecting natural stream flow.

E-7 Required Operating Procedure
Objective: Minimize disruption of caribou movement and subsistence use.
Requirement/Standard: Pipelines and roads shall be designed to allow the free movement of caribou and the safe, unimpeded passage of the public while participating in traditional subsistence activities. Listed below are the accepted design practices:

a. Above ground pipelines shall be elevated a minimum of 7 feet as measured from the ground to the bottom of the pipeline at vertical support members.

b. In areas where facilities or terrain may funnel caribou movement, ramps over pipelines, buried pipelines, or pipelines buried under roads may be required by the AO after consultation with federal, state, and NSB regulatory and resource agencies (as appropriate, based on agency legal authority and jurisdictional responsibility).

c. A minimum distance of 500 feet between pipelines and roads should be maintained when feasible. Separating roads from pipelines may not be feasible within narrow land corridors between lakes and where pipelines and roads converge on a drill pad.

E-8 Required Operating Procedure
Objective: Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.
Requirement/Standard: Gravel mine site design and reclamation will be in accordance with a plan approved by the AO. The plan shall consider:

a. Locations outside the active flood plain.

b. Design and construction of gravel mine sites within active flood plains to serve as water reservoirs for future use.

c. Potential use of the site for enhancing fish and wildlife habitat.

E-9 Required Operating Procedure
Objective: Avoidance of human-caused increases in populations of predators of ground nesting birds.
Requirement/Standard: Lessee shall utilize best available technology to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, and foxes. The lessee shall provide the AO with an annual report on the use of oil and gas facilities by ravens, raptors and foxes as nesting, denning, and shelter sites.

E-10 Required Operating Procedure
Objective: Prevention of migrating waterfowl, including species listed under the Endangered Species Act, from striking oil and gas and related facilities during low light conditions.
Requirement/Standard: Except for safety lighting, illumination of higher structures shall be designed to direct artificial exterior lighting inward and downward, rather than upward and outward. All drilling structures, production facilities, and other structures that exceed 20 feet in height shall be illuminated as outlined above.

E-11 Required Operating Procedure

Objective: Minimize the take of species listed under the Endangered Species Act and minimize the disturbance of other species of interest from direct or indirect interaction with oil and gas facilities.

Requirement/Standard: In accordance with the guidance below, before the approval of facility construction, aerial surveys of breeding pairs of the following species shall be conducted within any area proposed for development.

Special Conditions in Spectacled and/or Steller's Eiders Habitats:

a. Surveys shall be conducted by the lessee for at least 3 years before authorization of construction, if such construction is within the USFWS North Slope eider survey area and at least 1 year outside that area. Results of aerial surveys and habitat mapping may require additional ground nest surveys. Spectacled and/or Steller's eider surveys shall be conducted following accepted BLM-protocol during the second week of June.

b. If spectacled and/or Steller's eiders are determined to be present within the proposed development area, the applicant shall consult with the USFWS and BLM in the design and placement of roads and facilities in order to minimize impacts to nesting and brood-rearing eiders and their preferred habitats. Such consultation shall address timing restrictions and other temporary mitigating measures, construction of permanent facilities, placement of fill, alteration of eider habitat, aircraft operations, and introduction of high noise levels.

c. To reduce the possibility of spectacled and/or Steller's eiders striking above ground utility lines (power and communication), such lines shall either be buried in access roads, or suspended on vertical support members, to the extent practical. Support wires associated with communication towers, radio antennas, and other similar facilities, shall be clearly marked along their entire length to improve visibility for low flying birds. Such markings shall be jointly developed through consultation with the USFWS. Overhead power and/or communication lines for oil and gas activities will be limited to the following circumstances.

Special Conditions in Yellow-billed Loon Habitats:

a. Aerial surveys shall be conducted by the lessee for at least 3 years before authorization of construction of facilities proposed for development which are within 1 mile of a lake 25 acres or larger in size. These surveys along shorelines of large lakes shall be conducted following accepted BLM protocol during nesting in late June and during brood rearing in late August.

b. Should yellow-billed loons be present, the design and location of facilities must be such that disturbance is minimized. Accepted mitigation is a 1-mile buffer around all recorded nest sites and a minimum 1,625-foot (500-meter) buffer around the remainder of the lake shoreline. Development may be prohibited within buffers or activities curtailed while birds are present.

E-12 Required Operating Procedure

Objective: Use ecological mapping as a tool to assess wildlife habitat before development of permanent facilities, to conserve important habitat types during development.

Requirement/Standard: An ecological land classification map of the development area shall be developed before approval of facility construction. The map will integrate geomorphology, surface form, and vegetation at a scale, level of resolution, and level of positional accuracy adequate for detailed analysis of development alternatives. The map shall be prepared in time to plan one season of ground-based wildlife surveys, if deemed necessary by the AO, before approval of the exact facility location and facility construction.

E-13 Required Operating Procedure

Objective: Protect cultural and paleontological resources.

Requirement/Standard: Lessees shall conduct a cultural and paleontological resources survey prior to any ground-disturbing activity. Upon finding any potential cultural or paleontological resource, the lessee or their designated representative shall notify the AO and suspend all operations in the immediate area of such discovery until written authorization to proceed is issued by the AO.

Use of Aircraft for Permitted Activities:

F-1 Required Operating Procedure
Objective: Minimize the effects of low-flying aircraft on wildlife, traditional subsistence activities, and local communities.
Requirement/Standard: The lessee shall ensure that aircraft used for permitted activities maintain altitudes according to the following guidelines:

a. Aircraft shall maintain an altitude of at least 1,500 feet above ground level (AGL) when within ½ mile of cliffs identified as raptor nesting sites from April 15 through August 15 and within ½ mile of known gyrfalcon nest sites from March 15 to August 15, unless doing so would endanger human life or violate safe flying practices. Permitees shall obtain information from the BLM necessary to plan flight routes when routes may go near falcon nests.

b. Aircraft shall maintain an altitude of at least 1,000 feet AGL (except for takeoffs and landings) over caribou winter ranges from October 1 through May 1, unless doing so would endanger human life or violate safe flying practices. Caribou wintering areas will be defined annually by the AO.

c. The number of takeoffs and landings to support oil and gas operations with necessary materials and supplies should be limited to the maximum extent possible. During the design of proposed oil and gas facilities, larger landing strips and storage areas should be considered so as to allow larger aircraft to be employed, resulting in fewer flights to the facility.

d. Use of aircraft, especially rotary wing aircraft, near known subsistence camps and cabins or during sensitive subsistence hunting periods (spring goose hunting and fall caribou and moose hunting) should be kept to a minimum.

e. Aircraft used for permitted activities shall maintain an altitude of at least 2,000 feet AGL (except for takeoffs and landings) over the Teshekpuk Lake Caribou Habitat Area (Map 2-2) from May 20 through August 20, unless doing so would endanger human life or violate safe flying practices. Aircraft use (including fixed wing and helicopter) by oil and gas lessees in the Goose Molting Area (Map 2-2) should be minimized from May 20 through August 20, unless doing so would endanger human life or violate safe flying practices.

Oil Field Abandonment:

G-1 Lease Stipulation
Objective: Ensure the final disposition of the land meets the current and future needs of the public.
Requirement/Standard: Upon abandonment or expiration of the lease, all oil- and gas-related facilities shall be removed and sites rehabilitated to as near the original condition as practicable, subject to the review of the AO. The AO may determine that it is in the best interest of the public to retain some or all facilities.

Subsistence Consultation for Permitted Activities:

H-1 Required Operating Procedure

Objective: Provide opportunities for participation in planning and decision making to prevent unreasonable conflicts between subsistence uses and oil and gas and related activities.

Requirement/Standard: Lessee/permitee shall consult directly with affected communities using the following guidelines:

a. Before submitting an application to the BLM, the applicant shall consult with directly affected subsistence communities, the NSB, and the National Petroleum Reserve - Alaska Subsistence Advisory Panel to discuss the siting, timing and methods of proposed operations. Through this consultation, the applicant shall make every reasonable effort, including such mechanisms as conflict avoidance agreements and mitigating measures, to ensure that proposed activities will not result in unreasonable interference with subsistence activities.

b. The applicant shall submit documentation of consultation efforts as part of its operations plan. Applicants should submit the proposed plan of operations to provide an adequate time for review and comment by the National Petroleum Reserve - Alaska Subsistence Advisory Panel and to allow time for formal Government-to-Government consultation with Native Tribal governments. The applicant shall submit documentation of its consultation efforts and a written plan that shows how its activities, in combination with other activities in the area, will be scheduled and located to prevent unreasonable conflicts with subsistence activities. Operations plans must include a discussion of the potential effects of the proposed operation, and the proposed operation in combination with other existing or reasonably foreseeable operations.

c. A subsistence plan addressing the following items must be submitted:

1. A detailed description of the activity(ies) to take place (including the use of aircraft).
2. A description of how the lessee/permitee will minimize and/or deal with any potential impacts identified by the AO during the consultation process.
3. A detailed description of the monitoring effort to take place, including process, procedures, personnel involved and points of contact both at the work site and in the local community.
4. Communication elements to provide information on how the applicant will keep potentially affected individuals and communities up-to-date on the progress of the activities and locations of possible, short-term conflicts (if any) with subsistence activities. Communication methods could include holding community meetings, open house meetings, workshops, newsletters, radio and television announcements, etc.
5. Procedures necessary to facilitate access by subsistence users to conduct their activities.

In the event that no agreement is reached between the parties, the AO shall consult with the directly involved parties and determine which activities will occur, including the timeframes. During development, monitoring plans must be established for new permanent facilities, including pipelines, to assess an appropriate range of potential effects on resources and subsistence as determined on a case-by-case basis given the nature and location of the facilities. The scope, intensity, and duration of such plans will be established in consultation with the AO and Subsistence Advisory Panel.

H-2 Required Operating Procedure

Objective: Prevent unreasonable conflicts between subsistence activities and geophysical (seismic) exploration.

Requirement/Standard: In addition to the consultation process described above for permitted activities, before applying for permits to conduct geophysical (seismic) exploration, the applicant shall consult with local communities and residents.

Orientation Programs Associated with Permitted Activities:

I-1 Required Operating Procedure
Objective: Minimize cultural and resource conflicts.
Requirement/Standard: All personnel involved in oil and gas and related activities shall be provided information concerning applicable stipulations, ROPs, standards, and specific types of environmental, social, traditional, and cultural concerns that relate to the region. The lessee/permitee shall ensure that all personnel involved in permitted activities shall attend an orientation program at least once a year. The proposed orientation program shall be submitted to the AO for review and approval and should:

a. provide sufficient detail to notify personnel of applicable stipulations and ROPs as well as inform individuals working on the project of specific types of environmental, social, traditional and cultural concerns that relate to the region.
b. Address the importance of not disturbing archaeological and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals, and provide guidance on how to avoid disturbance.
c. Include guidance on the preparation, production, and distribution of information cards on endangered and/or threatened species.
d. Be designed to increase sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which personnel will be operating.
e. Include information concerning avoidance of conflicts with subsistence, commercial fishing activities, and pertinent mitigation.
f. Include information for aircraft personnel concerning subsistence activities and areas/seasons that are particularly sensitive to disturbance by low-flying aircraft. Of special concern is aircraft use near traditional subsistence cabins and campsites, flights during spring goose hunting and fall caribou and moose hunting seasons, and flights near North Slope communities.
g. Provide that individual training is transferable from one facility to another except for elements of the training specific to a particular site.
h. Include on-site records of all personnel who attend the program for so long as the site is active, though not to exceed the 5 most recent years of operations. This record shall include the name and dates(s) of attendance of each attendee.
i. Include a module discussing bear interaction plans to minimize conflicts between bears and humans.

Endangered Species Act—Section 7 Consultation Process:

J: The lease areas may now or hereafter contain plants, animals, or their habitats determined to be threatened, endangered, or to have some other special status. BLM may recommend modifications to exploration and development proposals to further its conservation and management objective to avoid BLM-approved activities that will contribute to the need to list such a species or their habitat. BLM may require modifications to or disapprove a proposed activity that is likely to result in jeopardy to the continued existence of a proposed or listed threatened or endangered species or result in the destruction or adverse modification of a designated or proposed critical habitat. BLM will not approve any ground-disturbing activity that may affect any such species or critical habitat until it completes its obligations under applicable requirements of the Endangered Species Act as amended, 16 USC § 1531 et seq., including completion of any required procedure for conference or consultation.

Lease Stipulations that Apply in Biologically Sensitive Areas:

K-1 Lease Stipulation - Rivers

Objective: Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas; the loss of spawning, rearing or over-wintering habitat for fish; the loss of cultural and paleontological resources; the loss of raptor habitat; impacts to subsistence cabin and campsites; the disruption of subsistence activities; and impacts to scenic and other resource values.

Requirement/Standard: Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited in the streambed and adjacent to the rivers listed below at the distances identified. With the exception of the Ikpikpuk River, these setbacks are measured from the bank of the river as determined by the hydrology at the time of application. The standard setback is ½ mile (from the bank's highest high water mark) and increased to ¾ mile (from the bank's highest high water mark) where subsistence cabin and campsites are numerous. Along the Colville River and a portion of the Ikpikpuk a 1-mile (from the bank's highest high water mark) setback is required to protect important raptor habitat (for locations along rivers where setback distances change). On a case-by case basis, and in consultation with federal, state, and NSB regulatory and resource agencies (as appropriate, based on agency legal authority and jurisdictional responsibility), essential pipeline and road crossings to the main channel will be permitted (unless noted otherwise) through setback areas. The above setbacks may not be practical within river deltas. In these situations, permanent facilities shall be designed to withstand a 200-year flood event.

a. **Colville River**: a 1-mile setback from the northern bluff (or bank if there is no bluff) of the Colville River extending the length of that portion of the river located within the Planning Area. Note: The Planning Area excludes conveyed Native lands along the lower reaches of the Colville River. Development of road crossings intended to support oil and gas activities shall be consolidated with other similar projects and uses to the maximum extent possible. Note: This provision does not apply to intercommunity or other permanent roads constructed with public funds for general transportation purposes. This preserves the opportunity to plan, design, and construct public transportation systems to meet the economic, transportation, and public health and safety needs of the State of Alaska and/or communities within National Petroleum Reserve - Alaska.

b. **Ikpikpuk River**: a ¾-mile setback from each side of the centerline (1½ miles total) of the Ikpikpuk River extending from the mouth south to Sec. 19, T. 7 N., R. 11 W., U.M. (Umiat Meridian). From Sec. 19, T. 7 N., R. 11 W., U.M., to Sec. 4, T. 3 N., R. 12 W., U.M., a 1-mile setback is required. Beginning at Sec. 4, T. 3 N., R. 12 W., U.M., a ½-mile setback from the centerline (1 mile total) will be required to the confluence of the Kigalik River and Maybe Creek. Note: The setback distances only apply to the east bank where the Ikpikpuk River is the Planning Area boundary.

c. **Miguakiak River**: a ½-mile setback from the bank's highest high water mark.

d. **Kikiakrorak and Kogosukruk Rivers**: Note: The following discussion refers only to portions of the Kikiakrorak River downstream from T. 2 N., R. 4 W., U.M. and the Kogosukruk River (including the four tributaries off the southern bank) downstream from T. 2 N., R. 3 W., U.M.. No permanent oil and gas surface facilities, except essential transportation crossings, would be allowed within 1 mile of the top of the bluff (or bank if there is no bluff) on either side of the rivers and several of the Kogosukruk tributaries.

e. **Fish Creek**: No permanent oil and gas surface facilities, except essential transportation crossings, would be allowed within 3 miles (from the bank's highest high water mark) of the creek downstream from the eastern edge of Sec. 31, T. 11 N., R. 1 E., U.M. or within ½ mile (from the bank's highest high water mark) of the creek farther upstream.

f. **Judy Creek**: a ½-mile setback from the banks' highest high water mark extending from the mouth to the confluence of an unnamed tributary in Sec. 8, T8N., R.2W., Umiat Meridian.
g. **Tingmiaksiqvik River**: No permanent oil and gas surface facilities, except essential transportation crossings, would be allowed within ½ mile (from the bank's highest high waster mark) of this river from its headwaters within Sec. 13, T. 7 N., R. 1 W., U.M. downstream to its confluence with Fish Creek. <u>Note: This stipulation applies only to Alternative B</u>.

K-2 Lease Stipulation--Deep Water Lakes
<u>Objective</u>: Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of deep water lakes; the loss of spawning, rearing or over wintering habitat for fish; the loss of cultural and paleontological resources; impacts to subsistence cabin and campsites; and the disruption of subsistence activities.
<u>Requirement/Standard</u>: Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited on the lake or lakebed and within ¼ mile of the ordinary high water mark of any deep lake as determined to be in lake zone III (i.e., depth greater than 13 feet [4 meters]; Mellor 1985). On a case-by case basis, and in consultation with federal, state and NSB regulatory and resource agencies (as appropriate based on agency legal authority and jurisdictional responsibility), essential pipeline, road crossings, and other permanent facilities may be permitted through or in these areas where the lessee can demonstrate on a site-specific basis that impacts would be minimal or if it is determined that there is no feasible or prudent alternative.

K-3 Stipulation - Teshekpuk Lake
Teshekpuk Lake contains sensitive biological resources and/or subsistence concerns. The standard(s) for exploration and development activities are set high with the burden of proof resting with the lessee to demonstrate to the AO that granting an approval for exploration and/or development is warranted.
<u>Objective:</u> Protect fish and wildlife habitat, preserve air and water quality, and minimize impacts to traditional subsistence activities and historic travel routes on Teshekpuk Lake.
<u>Requirement/Standard (Exploration)</u>: Requests for approval of any activities must be submitted in advance and must be accompanied by evidence and documentation that demonstrates to the satisfaction of the AO that the actions or activities meet all of the following criteria:
a. Exploration activities will not unreasonably conflict with traditional subsistence uses or significantly impact seasonally concentrated fish and wildlife resources.
b. There is adequate spill response capability to effectively respond during periods of broken ice and/or open water or, the availability of alternative methods to prevent well blowouts during periods when adequate response capability cannot be demonstrated. Such alternative methods may include improvements in blowout prevention technology, equipment, and/or changes in operational procedures, and "top-setting" of hydrocarbon-bearing zones.
c. Reasonable efforts to avoid or minimize impacts related to oil spill response activities, including vessel, aircraft, and pedestrian traffic will be made to minimize additional impacts or further compounding of "direct spill"-related impacts on area resources and subsistence uses.
d. The location of exploration and related activities shall be sited so as to not pose a hazard to navigation by the public using high-use traditional subsistence-related travel routes on Teshekpuk Lake, recognizing that marine and near-shore travel routes change over time, subject to shifting environmental conditions.
<u>Requirement/Standard (Development)</u>: With the exception of linear features such as pipelines and causeways, permanent oil and gas platforms or production equipment would not be permitted on or under the water within ¾ mile of the shoreline, and on land ¼ mile landward of

the shoreline of Teshekpuk Lake. Activities will only be permitted if they can meet all the following criteria:

a. Design and construction of facilities shall minimize impacts to traditional subsistence uses, travel corridors, and seasonally concentrated fish and wildlife resources.

b. Daily operational activities, including use of support vehicles, watercraft, and aircraft traffic, alone or in combination with other past, present, and reasonably foreseeable activities, shall be conducted to minimize impacts to traditional subsistence uses, travel corridors, and seasonally concentrated fish and wildlife resources.

c. The location of oil and gas facilities, including artificial islands, platforms, associated pipelines, ice or other roads, bridges or causeways, shall be sited and constructed so as to not pose a hazard to navigation by the public using traditional high-use subsistence-related travel routes into and through Teshekpuk Lake.

d. Demonstrated year-round oil spill response capability, including the capability of adequate response during periods of broken ice or open water, or the availability of alternative methods to prevent well blowouts during periods when adequate response capability cannot be demonstrated. Such alternative methods may include seasonal drilling restrictions, improvements in blowout prevention technology, equipment and/or changes in operational procedures, and "top-setting" of hydrocarbon-bearing zones.

e. Reasonable efforts will be made to avoid or minimize impacts related to oil spill response activities, including vessel, aircraft, and pedestrian traffic that add to impacts or further compound "direct spill" related impacts on area resources and subsistence uses.

K-4 Lease Stipulation - Goose Molting Area

Objective: Minimize disturbance to molting geese and loss of goose molting habitat in and around lakes in the Goose Molting Area.

Requirement/Standard: In goose molting habitats, the following standards will be followed for permitted activities:

a. Water extraction from any lake used by molting geese shall not alter hydrological conditions that could adversely affect identified goose-feeding habitat along lakeshore margins. Considerations will be given to seasonal use by operators (generally in winter) and geese (generally in summer), as well as recharge to lakes from the spring snowmelt.

b. From May 20 through August 20 drilling other than from current production pads is prohibited. The intent of this rule is to restrict exploration drilling during the period when geese are present. There are no seasonal restrictions on development or exploration drilling for fields in operation.

c. Oil and gas exploration and development activities will avoid alteration (e.g., damage or disturbance of soils, vegetation, or surface hydrology) of critical goose-feeding habitat types along lakeshore margins (grass/sedge/moss), as identified by the AO in consultation with the USFWS.

d. Permanent oil and gas facilities (including gravel roads, pads, and airstrips but excluding pipelines) and material sites will be sited to meet the stated objective. With the exception of linear features such as pipelines and causeways, permanent oil and gas platforms or production equipment would not be permitted on or under the water within ¾ mile of the shoreline, and on land ¼ mile landward of the shoreline of goose molting lakes. Goose Molting Area lakes shall be identified by the AO in consultation with appropriate federal, state, and NSB regulatory and resource agencies.

e. Oil and gas facility layout located within 1½ miles of a Goose Molting Area lake from May 20 through August 20 shall incorporate features (e.g., temporary fences, siting/orientation) that screen/shield human activity from view of any Goose Molting Area lake, as identified by the AO in consultation with appropriate federal, state, and NSB regulatory and resource agencies.

f. Major construction activities using heavy equipment (e.g., sand/gravel extraction and transport, pipeline and pad construction, but not drilling from existing production pads) shall be suspended within 1½ mile of the Goose Molting Area lakes from May 20 through August 20, unless approved by the AO in consultation with the appropriate federal, state, and NSB regulatory and resource agencies.
g. Strategies to minimize ground traffic will be implemented from May 20 through August 20. These strategies may include limiting trips, use of convoys, different vehicle types, etc. to the extent practicable.
h. Nonessential helicopter overflights by oil and gas lessees and all other users shall be reviewed and may be suspended in and around Goose Molting Area lakes from May 20 through August 20.
i. Within the Goose Molting Area, use of fixed-wing aircraft by authorized users shall be restricted from May 20 to August 20. Restrictions may include 1) limited to two round-trip flights/week, and 2) restricted to flight corridors will be established by the BLM after discussions with appropriate federal, state, and NSB regulatory and resource agencies. Note: This site-specific stipulation is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objective of this stipulation. However, flights necessary to gain this information would be restricted to the minimum necessary to collect such data.

K-5 Lease Stipulation - Teshekpuk Lake Caribou Habitat Area
Objective: Minimize disturbance and hindrance of caribou, or alteration of caribou movements through portions the Teshekpuk Lake Caribou Habitat Area that are essential for all season use, including calving and rearing, insect-relief, and migration.
Requirement/Standard: In the Teshekpuk Lake Caribou Habitat Area the following standards will be applied to permitted activities:
a. Before authorization of construction of permanent facilities, the lessee shall design and implement a study of caribou movement unless an acceptable study(s) has been completed within the last 10 years. The study shall include a minimum of 3 years of current data on caribou movements and the study design shall be approved by the AO and should provide information necessary to determine facility (including pipeline) design and location. Lessees may submit individual study proposals or they may combine with other lessees in the area to do a single, joint study for the entire Teshekpuk Lake Caribou Habitat Area. Study data may be gathered concurrently with other activities.
b. From May 20 through August 20, exploratory drilling will be allowed only from current production pads or platforms sited within a lake body, in compliance with setback requirements set forth in other stipulations.
c. Within the Teshekpuk Lake Caribou Habitat Area, lessees shall orient linear corridors when laying out oil field developments to the extent practicable, to address migration and corralling effects and to avoid loops of road and/or pipeline that connect facilities.
d. Ramps over pipelines, buried pipelines, or pipelines buried under the road may be required by the AO, after consultation with appropriate federal, state, and NSB regulatory and resource agencies, in the Teshekpuk Lake Caribou Habitat Area where pipelines potentially impede caribou movement.
e. The following ground-traffic restrictions shall apply to permanent oil and gas-related roads in the areas and time periods indicated:
1. Within the Teshekpuk Lake Caribou Habitat Area, from May 20 through August 20, traffic speed shall not exceed 15 miles per hour when caribou are within ½ mile on the road. Additional strategies may include limiting trips, using convoys, using different vehicle types, etc., to the extent practicable.

2. The lessee or a contractor shall observe caribou movement from May 20 through August 20. Based on these observations, traffic will be stopped temporarily to allow a crossing by 10 or more caribou. Sections of road will be evacuated when migrations of large numbers of caribou appears to imminent.
3. Major equipment, materials, and supplies to be used at oil and gas work sites in the Teshekpuk Lake Caribou Habitat Area shall be stockpiled prior to or after the period of May 20 through August 20 to minimize road traffic during that period.
4. Use of aircraft larger than a Twin Otter by authorized users of the Planning Area, including oil and gas lessees, from May 20 through August 20 within the Teshekpuk Lake Caribou Habitat Area, shall be for emergency purposes only.
5. Fixed-wing aircraft takeoffs and landings by authorized users of the Planning Area shall be limited to an average of one round-trip flight per day from May 20 through June 20, at aircraft facilities within the Teshekpuk Lake Caribou Habitat Areas.
6. Aircraft shall maintain a minimum height of 1,000 feet AGL (except for takeoffs and landings) over caribou winter ranges from October 1 through May 1, and 2,000 feet AGL over the Teshekpuk Lake Caribou Habitat Area from May 20 through August 20, unless doing so would endanger human life or violate safe flying practices.

K-6 Stipulation – Coastal Area
Objective: Minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas; to prevent contamination of marine waters; loss of important bird habitat; alteration or disturbance of shoreline marshes; and impacts to subsistence resources activities.
Requirement/Standard: In the Coastal Area, permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines established to support exploration and development activities shall be located at least ¾ mile inland from the coastline to the extent practicable. Where, as a result of technological limitations, economics, logistics, or other factors, a facility must be located within ¾ mile inland of the coastline, the practicality of locating the facility at previously occupied sites such as Camp Lonely, various Husky/USGS drill sites, and Distant Early Warning (DEW)-Line sites, shall be considered. Use of existing sites within ¾ mile of the coastline shall also be acceptable where it is demonstrated that use of such sites will reduce impacts to shorelines or otherwise be environmentally preferable. All lessees/permitees involved in activities in the immediate area must coordinate use of these new or existing sites with all other prospective users. Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission, the Nuiqsut Whaling Association, and the NSB to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope.

K-7 Lease Stipulation - Colville River Special Area
Objective: Prevent or minimize loss of raptor foraging habitat.
Requirement/Standard: If necessary to construct permanent facilities within the Colville River Special Area, all reasonable and practicable efforts shall be made to locate permanent facilities as far from raptor nests as feasible. Within 15 miles of raptor nest sites, significant alteration of high quality foraging habitat shall be prohibited unless the lessee can demonstrate on a site-specific basis that impacts would be minimal or it is determined that there is no feasible or prudent alternative. Of particular concern are ponds, lakes, wetlands, and riparian habitats. Note: On a case-by case basis, and in consultation with appropriate federal and state regulatory and resource agencies, essential pipeline and road crossings will be permitted through these areas where no other feasible or prudent options are available.

a. The following restrictions apply to overland moves, seismic work, and any similar use of heavy equipment (other than actual excavations as part of construction) on tundra surfaces during the winter season:

1. Motorized ground-vehicle use shall be minimized within the Colville River Raptor, Passerine, and Moose Area from April 15 through August 5, with the exception that use will be minimized in the vicinity of gyrfalcon nests beginning March 15. Such use will remain ½ mile away from known raptor nesting sites, unless authorized by the AO.

K-8 Lease Stipulation - Pik Dunes

Objective: Retain unique qualities of the Pik Dunes, including geologic and scenic uniqueness, insect-relief habitat for caribou, and habitat for several uncommon plant species.

Requirement/Standard: Surface structures, except approximately perpendicular pipeline crossings and ice pads, are prohibited within the Pik Dunes.

Summer Vehicle Tundra Travel:

L-1 Required Operating Procedure

Objective: Protect stream banks and water quality; minimize compaction and displacement of soils; minimize the breakage, abrasion, compaction, or displacement of vegetation; protect cultural and paleontological resources; maintain populations of, and adequate habitat for birds, fish, and caribou and other terrestrial mammals; and minimize impacts to subsistence activities.

Requirement/Standard: On a case-by-case basis, BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during times other than those identified in ROP C-2a. Permission for such use would only be granted after an applicant has:

a. Submitted studies satisfactory to the AO of the impacts on soils and vegetation of the specific low-ground-pressure vehicles to be used. These studies should reflect use of such vehicles under conditions similar to those of the route proposed for use and should demonstrate that the proposed use would have no more than minimal impacts to soils and vegetation.

b. Submitted surveys satisfactory to the AO of subsistence uses of the area as well as of the soils, vegetation, hydrology, wildlife and fish (and their habitats), paleontological and archaeological resources, and other resources as required by the AO.

c. Designed and/or modified the use proposal to minimize impacts to the AO's satisfaction. Design steps to achieve the objectives and based upon the studies and surveys may include, but not be limited to, timing restrictions (generally it is considered inadvisable to conduct tundra travel prior to August 1 to protect ground-nesting birds), shifting of work to winter, rerouting, and not proceeding when certain wildlife are present or subsistence activities are occurring. At the discretion of the AO, the plan for summer tundra vehicle travel may be included as part of the spill prevention and response contingency plan required by 40 CFR 112 (Oil Pollution Act) and ROP A-4.

Appendix F: Alternative D Stipulations and Required Operating Procedures

APPENDIX F

ALTERNATIVE D STIPULATIONS AND REQUIRED OPERATING PROCEDURES

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ALTERNATIVE D STIPULATIONS AND REQUIRED OPERATING PROCEDURES

Definitions

The following definitions in the context of this document, apply to general lease stipulations and site specific lease stipulations (K-Lease stipulations) and Required Operating Procedures (ROPs):

Active Floodplain: The lowland and relatively flat areas adjoining inland and coastal waters, including the flood-prone areas of offshore islands, composing, at a minimum, that area subject to a 1 percent or greater chance of flooding in any given year (also referred to as the 100-year or base floodplain).

Authorized Officer (AO): A position of authority for approval of various activities through delegation from the Secretary of the Interior. Currently, the designated AOs in the State of Alaska for leasing, surface use, and permitting are 1) State Director, 2) Manager of the Fairbanks District Office in Fairbanks, and 3) Deputy State Director, Division of Energy and Solid Minerals.

Body of Water or Water body: A lake, river, stream, creek, or pond that holds water throughout the summer and supports a minimum of aquatic life.

Buffer: A zone extending outward or inward from the periphery of a "protected" feature for a specified distance. Activities and development may be prohibited or limited by type or time within the buffer dependent on the goal associated with applying the buffer.

Consultation: Consultation, as it is referenced in the lease stipulations, does not infer formal consultation as required under other legal mandates such as "Section 7 Consultation" under the ESA. Rather, consultation implies that the BLM or the Lessee/Permittee will contact other agencies or entities to either inform them of potential actions and/or to seek input on noted topics. This includes informal contacts, and written, electronic, and/or verbal communication.

Development Activities: Any activity associated with construction and operation of facilities or equipment post exploration.

Field: The term used to describe the area containing surface infrastructure above one or more subsurface reservoirs. In this sense, "field" is analogous to "a Unit participating area or collection of participating areas." The infrastructure in the field includes, but is not limited to, drilling and production pads, service roads, perhaps an airstrip, and processing and support facilities. Field infrastructure may be used in the development and production of several oil/gas accumulations in different subsurface reservoirs. Fields typically have a primary reservoir that supports initial development in addition to satellite reservoirs that are developed later and tie

into the main facilities. Although oil and gas reservoirs may vary greatly in subsurface depth and other geologic characteristics, because they are located in the same geographic area it is more efficient to coordinate and share the necessary surface infrastructure. Fields may or may not be connected by permanent roads to adjacent fields or transportation facilities outside the field area.

In-field Roads: "In-field roads" are a component of the potential "footprint" of permanent oil and gas facilities. BLM defines "in-field roads" as gravel roads utilized by industry to conduct operational activities associated with development and production activities. The actual length/width and construction details of any gravel used for roads will be required as a component of any permit application for permanent facilities.

Lease Stipulation: Mitigation developed through BLM planning process/NEPA process that is specifically attached to any lease issued in the Northeast Planning Area.

Restricted Surface Occupancy*:* No permanent oil and gas facilities, except pipelines and in some cases roads, will be allowed.

Permanent Oil and Gas Facilities: Permanent Facilities include production facilities, pipelines, roads, airstrips, production pads, docks and other bottom-founded structures, seawater-treatment plants, and other structures associated with an oil and gas operation that occupy land for more than one winter season; also included are material sites such as sand and gravel. Exploration wellheads and seasonal facilities such as ice roads and ice pads are excluded, even when the pads are designed for use in successive winters. This definition does not include over-summering ice pads for exploration purposes.

Required Operating Procedure: Mitigation developed through the BLM planning process/NEPA process that is not attached to the oil and gas lease but is required, implemented and enforced at the operational level for all authorized (not just oil and gas) activities in the Planning Area.

Compliance with Required Operating Procedures: Required Operating Procedures were developed with various mechanisms in place to ensure compliance. These mechanisms include the following:

1) Some ROPs are pre-application requirements; therefore compliance will precede approval of the proposed activity. For example, ROP H-1 a. requires consultation with affected communities prior to submission of an application for relevant activities within the Northeast Planning Area. If consultation has not taken place, the application will be rejected or will be considered incomplete until such time that the consultation has occurred.
2) Other ROPs are required design features, and will have to be incorporated into the applicant's proposal. As an integral part of the proposal and the authorization, the requirement does not need to be stipulated to be enforceable. For example, a minimum pipeline height of 7 feet for above ground pipelines is a required design of any approved above ground pipeline (ROP E-7). Since the authorization (a ROW in this case) authorizes a pipeline with a minimum height of 7 feet, anything less (unless specifically approved through additional NEPA analysis and the permit) is not in compliance and enforcement actions may be taken even if the permit does not specify a minimum of 7 feet.

3) Other ROPs will become conditions of approval on post oil and gas lease land use authorizations and they will be enforceable. For example, ROP C-1 prohibits heavy equipment used for cross-country moves within ½ mile of occupied grizzly bear dens.

Site Specific Lease Stipulation (K-Stipulations): A mitigation measure developed through the BLM planning process/NEPA process attached only to leases issued within spatially defined areas in the Northeast Planning Area (See Map 1).

Temporary Platform: A facility that does not require the use of an ice or gravel pad to support oil and gas and related exploration activities. An example of a temporary platform recently used on the North Slope is Anadarko Petroleum's Arctic Drilling Platform used for the company's Hot Ice Project during the winters of 2003-2004. The facility consisted of a series of platform modules joined together and supported above the tundra surface on steel legs. Once the project was completed the platform was disassembled and the support legs were removed, leaving the tundra surface undisturbed.

Applicability of Requirements/Standards

All surface disturbing activities such as exploratory drilling, road/pipeline construction, seismic acquisition, and overland moves require additional authorization(s) issued subsequent to leasing. The stipulations and ROPs require that certain protections of resources and uses be achieved. Requirements and standards listed with the stipulations and ROPs represent BLM's current understanding of how lessees/permittees would achieve the objectives of the stipulation or ROP.

A lessee/permittee may propose a deviation from the requirements/standards of stipulations and ROPs as part of an authorization application. Prior to approving an alternative procedure as part of the authorization, BLM's staff would analyze the proposal and determine if the proposal incorporating the alternative procedure would achieve the objectives of the stipulations and ROPs. If the BLM determines that the alternative procedure proposed by the applicant would meet the stipulation's or ROP's objective, BLM could approve the alternative procedure.

If BLM determines that the alternative procedure proposed by the applicant is unlikely to meet the objectives of a stipulation or ROP, the AO may allow a deviation from the objectives and requirement/standard in a new decision document supported by additional NEPA analysis.

BLM could independently require different actions than those listed under requirements/standards. If, after experience or additional study, BLM concludes that a requirement/standard is not achieving or is unlikely to achieve the protective objective when applied to a specific future on-the-ground action or would not do so as well as the use of recently proven technology or techniques, BLM could at the permitting stage and under the terms of the stipulation or ROP, impose other restrictions to meet the objective.

Stipulations and Required Operating Procedures

Waste Prevention, Handling, Disposal, Spills and Public Safety:

A-1 Required Operating Procedure

Objective: Protect the health and safety of oil field workers and the general public by avoiding the disposal of solid waste and garbage near areas of human activity.
Requirement/Standard: Areas of operation shall be left clean of all debris.

A-2 Required Operating Procedure

Objective: Minimize impacts on the environment from non-hazardous waste generation. Encourage continuous environmental improvement. Protect the health and safety of oil field workers and the general public. Avoid human-caused changes in predator populations.
Requirement/Standard: Lessees/permittees shall prepare and implement a comprehensive waste management plan for all phases of exploration and development, including seismic activities. The plan shall be submitted to the AO for approval, in consultation with federal, state, and NSB regulatory and resource agencies, as appropriate (based on agency legal authority and jurisdictional responsibility), as part of a plan of operations or other similar permit application. Management decisions affecting waste generation shall be addressed in the following order of priority: 1) Prevention and reduction, 2) recycling, 3) treatment, and 4) disposal. The plan shall consider and take into account the following requirements:

a. Methods to avoid attracting wildlife to food and garbage. All feasible precautions shall be taken to avoid attracting wildlife to food and garbage. (A list of approved precautions, specific to the type of permitted use, can be obtained from the AO.)

b. Disposal of putrescible waste. Requirements prohibit the burial of garbage. Lessees and permitted users shall have a written procedure to ensure that the handling and disposal of putrescible waste will be accomplished in a manner that prevents the attraction of wildlife. All putrescible waste shall be incinerated, backhauled, or composted in a manner approved by the AO. All solid waste, including incinerator ash, shall be disposed of in an approved waste-disposal facility in accordance with USEPA and ADEC regulations and procedures. The burial of human waste is prohibited except as authorized by the AO.

c. Disposal of pumpable waste products. Except as specifically provided, the BLM requires that all pumpable solid, liquid, and sludge waste be disposed of by injection in accordance with USEPA, ADEC, and the Alaska Oil and Gas Conservation Commission regulations and procedures. On-pad temporary muds and cuttings storage, as approved by ADEC, will be allowed as necessary to facilitate annular injection and/or backhaul operations.

d. Disposal of wastewater and domestic wastewater. The BLM prohibits wastewater discharges or disposal of domestic wastewater into bodies of fresh, estuarine, and marine water, including wetlands, unless authorized by the NPDES or state permit.

A-3 Required Operating Procedure

Objective: Minimize pollution through effective hazardous-materials contingency planning.
Requirement/Standard: For oil- and gas-related activities, a Hazardous Materials Emergency Contingency Plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances. The plan shall include a set of procedures to ensure prompt response, notification, and cleanup in the event of a hazardous substance spill or threat of a release. Procedures applicable to fuel and hazardous substances handling (associated with transportation vehicles) may consist of Best Management Practices (BMPs) if approved by the AO. The plan shall include a list of resources available for response (e.g., heavy-equipment operators, spill-cleanup materials or companies), and names and phone numbers of Federal,

state, and NSB contacts. Other federal and state regulations may apply and require additional planning requirements. All staff shall be instructed regarding these procedures.

A-4 Required Operating Procedure

Objective: Minimize the impact of contaminants on fish, wildlife, and the environment, including wetlands, marshes and marine waters, as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and subsistence activities. Protect public health and safety.

Requirement/Standard: Before initiating any oil and gas or related activity or operation, including field research/surveys and/or seismic operations, lessees/permittees shall develop a comprehensive spill prevention and response contingency plan per 40 CFR § 112 (Oil Pollution Act). The plan shall consider and take into account the following requirements:

a. On-site Clean-up Materials. Sufficient oil-spill-cleanup materials (absorbents, containment devices, etc...) shall be stored at all fueling points and vehicle-maintenance areas and shall be carried by field crews on all overland moves, seismic work trains, and similar overland moves by heavy equipment.

b. Storage Containers. Fuel and other petroleum products and other liquid chemicals shall be stored in proper containers at approved locations. Except during overland moves and seismic operations, fuel, other petroleum products, and other liquid chemicals designated by the AO in excess of 1,320 gallons in storage capacity shall be stored within an impermeable lined and diked area or within approved alternate storage containers, such as over packs, capable of containing 110 percent of the stored volume.

c. Liner Materials. Liner material shall be compatible with the stored product and capable of remaining impermeable during typical weather extremes expected throughout the storage period.

d. Permanent Fueling Stations. Permanent fueling stations shall be lined or have impermeable protection to prevent fuel migration to the environment from overfills and spills.

e. Proper Identification of Containers. All fuel containers, including barrels and propane tanks, shall be marked with the responsible party's name, product type, and year filled or purchased.

f. Notice of Reportable Spills. Notice of any reportable spill (as required by 40 CFR § 300.125 and 18 AAC § 75.300) shall be given to the AO as soon as possible, but no later than 24 hours after occurrence.

g. Identification of Oil Pans *("duck ponds")*. All oil pans shall be marked with the responsible party's name.

A-5 Required Operating Procedure

Objective: Minimize the impact of contaminants from refueling operations on fish, wildlife and the environment.

Requirement/Standard: Refueling of equipment within 500 feet of the active flood plain of any fish-bearing water body and 100 feet of non-fish-bearing water bodies is prohibited. Small caches (up to 210 gallons) for motorboats, float planes, ski planes, and small equipment, e.g. portable generators and water pumps, will be permitted. The AO may allow storage and operations at areas closer than the stated distances if properly designed to account for local hydrologic conditions.

A-6 Required Operating Procedure

Objective: Minimize the impact on fish, wildlife, and the environment from contaminants associated with the exploratory drilling process.

Requirement/Standard: Surface discharge of reserve-pit fluids is prohibited unless authorized by applicable NPDES, ADEC, and NSB permits (as appropriate) and approved by the AO.

A-7 Required Operating Procedure
Objective: Minimize the impacts to the environment of disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment.
Requirement/Standard: Procedures for the disposal of produced fluids shall meet the following requirements:

a. In upland areas, including wetlands, disposal will be by subsurface-disposal techniques. The AO may permit alternate disposal methods if the lessee demonstrates that subsurface disposal is not feasible or prudent and the alternative method will not result in adverse environmental effects.

b. In marine waters, approval of discharges by the AO will be based on a case-by-case review of environmental factors and consistency with the conditions of an NPDES permit. Discharge of produced fluids will be prohibited at locations where currents and water depths, in combination with other conditions, are not adequate to prevent impacts to known biologically sensitive areas. Alternate disposal methods will require an NPDES permit certified by the state.

A-8 Required Operating Procedure
Objective: Minimize conflicts resulting from interaction between humans and bears during leasing and associated activities.
Requirement: Oil and gas lessees and their contractors and subcontractors will, as a part of preparation of lease operation planning, prepare and implement bear-interaction plans to minimize conflicts between bears and humans. These plans shall include measures to:

a. Minimize attraction of bears to the drill sites.
b. Organize layout of buildings and work areas to minimize human/bear interactions.
c. Warn personnel of bears near or on drill sites and identify proper procedures to be followed.
d. Establish procedures, if authorized, to discourage bears from approaching the drill site.
e. Provide contingencies in the event bears do not leave the site or cannot be discouraged by authorized personnel.
f. Discuss proper storage and disposal of materials that may be toxic to bears.
g. Provide a systematic record of bears on the site and in the immediate area.
h. Encourage lessee/permittee to participate and comply with the Incidental Take Program under the Marine Mammal Protection Act.

Water Use for Permitted Activities:

B-1 Required Operating Procedure
Objective: Maintain populations of, and adequate habitat for, fish and invertebrates.
Requirement/Standard: Water withdrawal from rivers and streams during winter is prohibited.

B-2 Required Operating Procedure
Objective: Maintain natural hydrologic regimes in soils surrounding lakes and ponds, and maintain populations of, and adequate habitat for, fish and invertebrates, and waterfowl.
Requirement/Standard: Water withdrawal from lakes may be authorized on a site-specific basis depending on lake size, water volume, and depth, and fish population and species diversification. Water withdrawal requirements specify:

a. Lakes that are ≥7 feet with sensitive fish (any fish except ninespine stickleback or Alaska blackfish), water available for withdrawal is limited to 15% of calculated volume deeper than 7 feet; lakes that are between 5 and 7 feet with sensitive fish, water available for withdrawal would be calculated on a case by case basis.

b. Lakes that are ≥5 feet with only non-sensitive fish (i.e., ninespine stickleback or Alaska blackfish), water is available for withdrawal is limited to 30% of calculated volume deeper than 5 feet.
c. Any lake with no fish present, regardless of depth, water available for withdrawal is up to 100% as specified within the permit.
d. A water-monitoring plan may be required to assess draw down and water quality changes before, during, and after pumping any fish-bearing lake or lake of special concern.
e. The removal of naturally grounded ice may be authorized from lakes and shallow rivers on a site-specific basis depending upon its size, water volume, and depth, and fish population and species diversification.
f. Removed ice aggregate shall be included in the 15 percent or 30 percent withdrawal limits—whichever is the appropriate case—unless otherwise approved.
g. Any water intake structures in fish bearing or non-fish bearing waters shall be designed, operated, and maintained to prevent fish entrapment, entrainment, or injury. <u>Note: All water withdrawal equipment must be equipped and must utilize fish screening devices approved by the Alaska Department of Natural Resources (ADNR).</u>
h. Compaction of snow cover or snow removal from fish-bearing water bodies shall be prohibited except at approved ice road crossings, water pumping stations on lakes, or areas of grounded ice.

The following lease stipulations and ROPs apply to overland moves, seismic work, and any similar cross-country vehicle use of heavy equipment on non-roaded surfaces during the winter season. These restrictions do not apply to the use of such equipment on ice roads after they are constructed.

Winter Overland Moves and Seismic Work:

C-1 Required Operating Procedure
<u>Objective</u>: Protect grizzly bear, polar bear, and marine mammal denning and/or birthing locations.
<u>Requirement/Standard</u>:
a. Cross-country use of heavy equipment and seismic activities is prohibited within ½ mile of occupied grizzly bear dens identified by the ADFG unless alternative protective measures are approved by the AO in consultation with the ADFG.
b. Cross-country use of heavy equipment and seismic activities is prohibited within 1 mile of known or observed polar bear dens or seal birthing lairs. Operators shall consult with the USFWS and/or NOAA Fisheries, as appropriate, before initiating activities in coastal habitat between October 30 and April 15.

C-2 Required Operating Procedure
<u>Objective</u>: Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.
<u>Requirement/Standard:</u>
a. Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect the tundra. Ground operations shall cease when the spring snowmelt begins (approximately May 5 in the foothills area where elevations reach or exceed 500 feet and approximately May 15 in the northern coastal areas). The exact dates will be determined by the AO.
b. Only low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. A list of approved vehicles can be obtained from the AO. Limited use of tractors equipped with wide tracks or "shoes" will be allowed to pull trailers, sleighs or other equipment with

approved undercarriage. Note: This provision does not include the use of heavy equipment such as front-end loaders and similar equipment required during ice road construction.
c. Bulldozing of tundra mat and vegetation, trails, or seismic lines is prohibited; however, on existing trails, seismic lines or camps, clearing of drifted snow is allowed to the extent that the tundra mat is not disturbed.
d. To reduce the possibility of ruts, vehicles shall avoid using the same trails for multiple trips unless necessitated by serious safety or superseding environmental concern. This provision does not apply to hardened snow trails for use by low-ground-pressure vehicles such as Rolligons.
e. The location of winter ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation. Offsets may be required to avoid using the same route or track in the subsequent year.
f. Motorized ground-vehicle use within the CRSA associated with overland moves, seismic work, and any similar use of heavy equipment shall be minimized within the Colville River Raptor, Passerine, and Moose Area from April 15 through August 5, with the exception that use will be minimized in the vicinity of gyrfalcon nests beginning March 15. Such use will remain ½ mile away from known raptor nesting sites, unless authorized by the AO.

C-3 Required Operating Procedure
Objective: Maintain natural spring runoff patterns and fish passage, avoid flooding, prevent streambed sedimentation and scour, protect water quality and protect stream banks.
Requirement/Standard: Crossing of waterway courses shall be made using a low-angle approach. Snow and ice bridges shall be removed, breached, or slotted before spring breakup. Ramps and bridges shall be substantially free of soil and debris.

C-4 Required Operating Procedure
Objective: Avoid additional freeze-down of deep-water pools harboring over-wintering fish and invertebrates used by fish.
Requirement/Standard: Travel up and down streambeds is prohibited unless it can be demonstrated that there will be no additional impacts from such travel to over-wintering fish or the invertebrates they rely on. Rivers and streams shall be crossed at shallow riffles from point bar to point bar whenever possible.

Oil and Gas Exploratory Drilling:

D-1 Lease Stipulation
Objectives: Protect fish-bearing rivers, streams, and lakes from blowouts and minimize alteration of riparian habitat.
Requirement/Standard: Exploratory drilling is prohibited in rivers and streams, as determined by the active floodplain, and fish-bearing lakes.

D-2 Lease Stipulation
Objective: Minimize surface impacts from exploratory drilling.
Requirement/Standard: Exploratory drilling shall be limited to temporary facilities such as ice pads, ice roads, and ice airstrips, unless a proposal is to use a previously constructed road or pad and it is environmentally preferable.

Facility Design and Construction:

E-1 Required Operating Procedure

Objective: Protect subsistence use and access to traditional subsistence hunting and fishing areas and minimize the impact of oil and gas activities on air, land, water, fish and wildlife resources.

Requirement/Standard: All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and to protect subsistence use and access to traditional subsistence hunting and fishing areas. Subject to approval by the AO, the construction, operation and maintenance of oil field roads is the responsibility of the lessee unless the construction, operation, and maintenance of roads are assumed by the appropriate governing entity.

E-2 Lease Stipulation

Objective: Protect fish-bearing water bodies, water quality, and aquatic habitats.

Requirement/Standard: The design and location of permanent oil and gas facilities within 500 feet of fish-bearing or 100 feet of non-fish-bearing water bodies will only be approved on a case by case basis if the lessee can demonstrate that impacts to fish, water quality, and aquatic and riparian habitats are minimal. Note: Also refer to Area-Specific Stipulations and ROPs for Rivers Area (*Lease Stipulation K-1*) and Deep Water Lakes (*Lease Stipulation K-2*).

E-3 Lease Stipulation

Objective: Maintain free passage of marine and anadromous fish and protect subsistence use and access to traditional subsistence hunting and fishing.

Requirement/Standard: Causeways and docks are prohibited in river mouths or deltas. Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas. Causeways, docks, artificial islands, and bottom-founded structures shall be designed to ensure free passage of marine and anadromous fish and to prevent significant changes to nearshore oceanographic circulation patterns and water quality characteristics. A monitoring program may be required to address the objectives of water quality and free passage of fish.

E-4 Required Operating Procedure

Objective: Minimize the potential for pipeline leaks, the resulting environmental damage and industrial accidents.

Requirement/Standard: All pipelines shall be designed, constructed, and operated under an AO-approved Quality Assurance/Quality Control plan that is specific to the product transported.

E-5 Required Operating Procedure

Objective: Minimize impacts of the development footprint.

Requirement/Standard: Facilities shall be designed and located to minimize the development footprint to the maximum extent practicable considering environmental, economic, safety, and social impacts. Note: Where aircraft traffic is a concern, consideration shall be given to balancing gravel pad size and available supply storage capacity with potential reductions in the use of aircraft to support oil and gas operations.

E-6 Required Operating Procedure

Objective: Reduce the potential for ice-jam flooding, impacts to wetlands and floodplains, erosion, alteration of natural drainage patterns, and restriction of fish passage.

Requirement/Standard: Stream and marsh crossings shall be designed and constructed to ensure free passage of fish, maintain natural drainage, and minimize adverse effects to natural

stream flow. Note: Bridges, rather than culverts, are the preferred method for crossing rivers. When necessary, culverts can be constructed on smaller streams, if they are large enough to avoid restricting fish passage or adversely affecting natural stream flow.

E-7 Required Operating Procedure
Objective: Minimize disruption of caribou movement and subsistence use.
Requirement/Standard: Pipelines and roads shall be designed to allow the free movement of caribou and the safe, unimpeded passage of the public while participating in traditional subsistence activities. Listed below are the accepted design practices:
a. Above ground pipelines shall be elevated a minimum of 7 feet as measured from the ground to the bottom of the pipeline at vertical support members.
b. In areas where facilities or terrain may funnel caribou movement, ramps over pipelines, buried pipelines, or pipelines buried under roads may be required by the AO after consultation with federal, state, and NSB regulatory and resource agencies (as appropriate, based on agency legal authority and jurisdictional responsibility).
c. A minimum distance of 500 feet between pipelines and roads shall be maintained. Separating roads from pipelines may not be feasible within narrow land corridors between lakes and where pipelines and roads converge on a drill pad. Where it is not feasible to separate pipelines and roads, alternative pipeline routes, designs and possible burial within the road will be considered by the AO.

E-8 Required Operating Procedure
Objective: Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.
Requirement/Standard: Gravel mine site design and reclamation will be in accordance with a plan approved by the AO. The plan shall consider:
a. Locations outside the active flood plain.
b. Design and construction of gravel mine sites within active flood plains to serve as water reservoirs for future use.
c. Potential use of the site for enhancing fish and wildlife habitat.

E-9 Required Operating Procedure
Objective: Avoidance of human-caused increases in populations of predators of ground nesting birds.
Requirement/Standard:
a. Lessee shall utilize best available technology to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, and foxes. The lessee shall provide the AO with an annual report on the use of oil and gas facilities by ravens, raptors and foxes as nesting, denning, and shelter sites.
b. Feeding of wildlife is prohibited and will be subject to non-compliance regulations.

E-10 Required Operating Procedure
Objective: Prevention of migrating waterfowl, including species listed under the Endangered Species Act, from striking oil and gas and related facilities during low light conditions.
Requirement/Standard: Except for safety lighting, illumination of higher structures shall be designed to direct artificial exterior lighting inward and downward, rather than upward and outward. All drilling structures, production facilities, and other structures that exceed 20 feet in height shall be illuminated as outlined above.

E-11 Required Operating Procedure
Objective: Minimize the take of species listed under the Endangered Species Act and minimize the disturbance of other species of interest from direct or indirect interaction with oil and gas facilities.
Requirement/Standard: In accordance with the guidance below, before the approval of facility construction, aerial surveys of the following species shall be conducted within any area proposed for development.

Special Conditions in Spectacled and/or Steller's Eiders Habitats:

a. Surveys shall be conducted by the lessee for at least 3 years before authorization of construction, if such construction is within the USFWS North Slope eider survey area and at least 1 year outside that area. Results of aerial surveys and habitat mapping may require additional ground nest surveys. Spectacled and/or Steller's eider surveys shall be conducted following accepted BLM-protocol during the second week of June.

b. If spectacled and/or Steller's eiders are determined to be present within the proposed development area, the applicant shall consult with the USFWS and BLM in the design and placement of roads and facilities in order to minimize impacts to nesting and brood-rearing eiders and their preferred habitats. Such consultation shall address timing restrictions and other temporary mitigating measures, construction of permanent facilities, placement of fill, alteration of eider habitat, aircraft operations, and introduction of high noise levels.

c. To reduce the possibility of spectacled and/or Steller's eiders striking above ground utility lines (power and communication), such lines shall either be buried in access roads, or suspended on vertical support members, to the extent practicable. Support wires associated with communication towers, radio antennas, and other similar facilities, shall be clearly marked along their entire length to improve visibility for low flying birds. Such markings shall be jointly developed through consultation with the USFWS.

1. Overhead power or communication lines may be allowed when located entirely within the boundaries of a facility pad;
2. Overhead power or communication lines may be allowed when engineering constraints at the specific location make it unfeasible to bury or connect them to a vertical support member, or
3. Overhead power or communication lines may be allowed when human safety would be compromised by other methods. (Note: This requirement standard would be Planning Area wide.)

Special Conditions in Yellow-billed Loon Habitats:

a. Aerial surveys shall be conducted by the lessee for at least 3 years before authorization of construction of facilities proposed for development which are within 1 mile of a lake 25 acres or larger in size. These surveys along shorelines of large lakes shall be conducted following accepted BLM protocol during nesting in late June and during brood rearing in late August.

b. Should yellow-billed loons be present, the design and location of facilities must be such that disturbance is minimized. The default standard mitigation is a 1-mile buffer around all recorded nest sites and a minimum 1,625-foot (500-meter) buffer around the remainder of the shoreline. Development will generally be prohibited within buffers unless no other option exists.

E-12 Required Operating Procedure
Objective: Use ecological mapping as a tool to assess wildlife habitat before development of permanent facilities, to conserve important habitat types during development.
Requirement/Standard: An ecological land classification map of the development area shall be developed before approval of facility construction. The map will integrate geomorphology, surface form, and vegetation at a scale, level of resolution, and level of positional accuracy adequate for detailed analysis of development alternatives. The map shall be prepared in time

to plan one season of ground-based wildlife surveys, if deemed necessary by the AO, before approval of the exact facility location and facility construction.

E-13 Required Operating Procedure
Objective: Protect cultural and paleontological resources.
Requirement/Standard: Lessees shall conduct a cultural and paleontological resources survey prior to any ground-disturbing activity. Upon finding any potential cultural or paleontological resource, the lessee or their designated representative shall notify the AO and suspend all operations in the immediate area of such discovery until written authorization to proceed is issued by the AO.

Use of Aircraft for Permitted Activities:

F-1 Required Operating Procedure
Objective: Minimize the effects of low-flying aircraft on wildlife, traditional subsistence activities, and local communities.
Requirement/Standard: The lessee shall ensure that aircraft used for permitted activities maintain altitudes according to the following guidelines:

a. Aircraft shall maintain an altitude of at least 1,500 feet above ground level (AGL) when within ½ mile of cliffs identified as raptor nesting sites from April 15 through August 15 and within ½ mile of known gyrfalcon nest sites from March 15 to August 15, unless doing so would endanger human life or violate safe flying practices. Permitees shall obtain information from the BLM necessary to plan flight routes when routes may go near falcon nests.

b. Aircraft shall maintain an altitude of at least 1,000 feet AGL (except for takeoffs and landings) over caribou winter ranges from October 1 through May 1, unless doing so would endanger human life or violate safe flying practices. Caribou wintering areas will be defined annually by the AO. The AO will consult directly with the Alaska Department of Fish and Game in annually defining caribou winter ranges.

c. Land user shall submit an aircraft use plan as part of an oil and gas exploration or development proposal. The plan shall address strategies to minimize impacts to subsistence hunting and associated activities, including but not limited to the number of flights, type of aircraft, and flight altitudes and routes, and shall also include a plan to monitor flights. Proposed aircraft use plans should be reviewed by appropriate Federal, State, and Borough agencies. Consultations with these same agencies will be required if unacceptable disturbance is identified by subsistence users. Adjustments, including possible suspension of all flights, may be required by the AO if resulting disturbance is determined to be unacceptable. The number of takeoffs and landings to support oil and gas operations with necessary materials and supplies should be limited to the maximum extent possible. During the design of proposed oil and gas facilities, larger landing strips and storage areas should be considered so as to allow larger aircraft to be employed, resulting in fewer flights to the facility.

d. Use of aircraft, especially rotary wing aircraft, near known subsistence camps and cabins or during sensitive subsistence hunting periods (spring goose hunting and fall caribou and moose hunting) should be kept to a minimum.

e. Aircraft used for permitted activities shall maintain an altitude of at least 2,000 feet AGL (except for takeoffs and landings) over the Teshekpuk Lake Caribou Habitat Area (Map 2-4) from May 20 through August 20, unless doing so would endanger human life or violate safe flying practices. Aircraft use (including fixed wing and helicopter) by oil and gas lessees in the Goose Molting Area (Map 2-5) should be minimized from May 20 through August 20, unless doing so would endanger human life or violate safe flying practices.

Oil Field Abandonment:

G-1 Lease Stipulation
Objective: Ensure the final disposition of the land meets the current and future needs of the public.
Requirement/Standard: Upon abandonment or expiration of the lease, all oil- and gas-related facilities shall be removed and sites rehabilitated to as near the original condition as practicable, subject to the review of the AO. The AO may determine that it is in the best interest of the public to retain some or all facilities. Within the Goose Molting Area, the AO, when determining if it is in the best interest of the public to retain a facility, will consider the impacts of retention to molting geese and goose molting habitat.

Subsistence Consultation for Permitted Activities:

H-1 Required Operating Procedure
Objective: Provide opportunities for participation in planning and decision making to prevent unreasonable conflicts between subsistence uses and oil and gas and related activities.
Requirement/Standard: Operational activities will be prohibited within a minimum distance of 1 mile around cabins and campsites (as identified by the NSB's official inventory) without alternate agreement between the operator and the cabin/campsite users/owners.
Lessee/permittee shall consult directly with affected communities using the following guidelines:

a. Before submitting an application to the BLM, the applicant shall consult with directly affected subsistence communities, the NSB, and the National Petroleum Reserve - Alaska Subsistence Advisory Panel to discuss the siting, timing and methods of proposed operations. Through this consultation, the applicant shall make every reasonable effort, including such mechanisms as conflict avoidance agreements and mitigating measures, to ensure that proposed activities will not result in unreasonable interference with subsistence activities.

b. The applicant shall submit documentation of consultation efforts as part of its operations plan. Applicants should submit the proposed plan of operations to provide an adequate time for review and comment by the National Petroleum Reserve - Alaska Subsistence Advisory Panel and to allow time for formal Government-to-Government consultation with Native Tribal governments. The applicant shall submit documentation of its consultation efforts and a written plan that shows how its activities, in combination with other activities in the area, will be scheduled and located to prevent unreasonable conflicts with subsistence activities. Operations plans must include a discussion of the potential effects of the proposed operation, and the proposed operation in combination with other existing or reasonably foreseeable operations.

c. A subsistence plan addressing the following items must be submitted:

1. A detailed description of the activity(ies) to take place (including the use of aircraft).
2. A description of how the lessee/permittee will minimize and/or deal with any potential impacts identified by the AO during the consultation process.
3. A detailed description of the monitoring effort to take place, including process, procedures, personnel involved and points of contact both at the work site and in the local community.
4. Communication elements to provide information on how the applicant will keep potentially affected individuals and communities up-to-date on the progress of the activities and locations of possible, short-term conflicts (if any) with subsistence activities. Communication methods could include holding community meetings, open house meetings, workshops, newsletters, radio and television announcements, etc.
5. Procedures necessary to facilitate access by subsistence users to conduct their activities.

In the event that no agreement is reached between the parties, the AO shall consult with the directly involved parties and determine which activities will occur, including the timeframes. During development, monitoring plans must be established for new permanent facilities, including pipelines, to assess an appropriate range of potential effects on resources and subsistence as determined on a case-by-case basis given the nature and location of the facilities. The scope, intensity, and duration of such plans will be established in consultation with the AO and Subsistence Advisory Panel.
Permittees that propose barging facilities, equipment, supplies, or other materials to NPR-A in support of oil and gas activities in the planning area shall notify, confer, and coordinate with the Alaska Eskimo Whaling Commission, the appropriate local community whaling captains' associations, and the NSB to minimize impacts from the proposed barging on subsistence whaling activities.

H-2 Required Operating Procedure
Objective: Prevent unreasonable conflicts between subsistence activities and geophysical (seismic) exploration.
Requirement/Standard: In addition to the consultation process described in ROP H-1 for permitted activities, before applying for permits to conduct geophysical (seismic) exploration, the applicant shall consult with local communities and residents and 2.) notify the local Search and Rescue organizations of current and recent seismic surveys. For the purpose of this standard, a potentially affected cabin/campsite is defined as any camp or campsite within the boundary of the area subject to proposed geophysical exploration and/or within 1 mile of actual or planned travel routes used to supply the seismic operations while it is in operation.

- Because of the large land area covered by typical geophysical operations and the potential to impact a large number of subsistence users during the exploration season, the permittee/operator will notify in writing all potentially affected long-term cabin and camp users.
- The official recognized list of cabin and campsite users is the NSB's 2001 inventory of cabins and campsites.
- A copy of the notification letter and a list of potentially affected users shall also be provided to the office of the appropriate Native Tribal government.
- The AO will prohibit seismic work within 1 mile of any known, long-term, cabin or campsite unless an alternate agreement between the cabin/campsite owner/user is reached through the consultation process and presented to the AO. (Regardless of the consultation outcome, the AO will prohibit wintertime seismic work within 300 feet of a known long-term cabin or campsite.)
- The permittee shall notify the appropriate local Search and Rescue (e.g., Nuiqsut Search and Rescue, Atqasuk Search and Rescue) of their current operational location within the NPR-A on a weekly basis. This notification should include a map indicating the current extent of surface use and occupation, as well as areas previously used/occupied during the course of the operation in progress. The purpose of this notification is to allow hunters up-to-date information regarding where seismic exploration is occurring, and has occurred, so that they can plan their hunting trips and access routes accordingly. Identification of the appropriate Search and Rescue offices to be contacted can be obtained from the NPR-A Subsistence Advisory Panel.

Orientation Programs Associated with Permitted Activities:

I-1 Required Operating Procedure
Objective: Minimize cultural and resource conflicts.

Requirement/Standard: All personnel involved in oil and gas and related activities shall be provided information concerning applicable stipulations, ROPs, standards, and specific types of environmental, social, traditional, and cultural concerns that relate to the region. The lessee/permitee shall ensure that all personnel involved in permitted activities shall attend an orientation program at least once a year. The proposed orientation program shall be submitted to the AO for review and approval and should:

a. provide sufficient detail to notify personnel of applicable stipulations and ROPs as well as inform individuals working on the project of specific types of environmental, social, traditional and cultural concerns that relate to the region.

b. Address the importance of not disturbing archaeological and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals, and provide guidance on how to avoid disturbance.

c. Include guidance on the preparation, production, and distribution of information cards on endangered and/or threatened species.

d. Be designed to increase sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which personnel will be operating.

e. Include information concerning avoidance of conflicts with subsistence, commercial fishing activities, and pertinent mitigation.

f. Include information for aircraft personnel concerning subsistence activities and areas/seasons that are particularly sensitive to disturbance by low-flying aircraft. Of special concern is aircraft use near traditional subsistence cabins and campsites, flights during spring goose hunting and fall caribou and moose hunting seasons, and flights near North Slope communities.

g. Provide that individual training is transferable from one facility to another except for elements of the training specific to a particular site.

h. Include on-site records of all personnel who attend the program for so long as the site is active, though not to exceed the 5 most recent years of operations. This record shall include the name and dates(s) of attendance of each attendee.

i. Include a module discussing bear interaction plans to minimize conflicts between bears and humans.

j. Provide a copy of 43 CFR 3163 regarding Non-Compliance Assessment and Penalties to on-site personnel.

Endangered Species Act—Section 7 Consultation Process:

J. The lease areas may now or hereafter contain plants, animals, or their habitats determined to be threatened, endangered, or to have some other special status. The BLM may recommend modifications to exploration and development proposals to further its conservation and management objective to avoid BLM-approved activities that will contribute to the need to list such a species or their habitat. The BLM may require modifications to or disapprove a proposed activity that is likely to result in jeopardy to the continued existence of a proposed or listed threatened or endangered species or result in the destruction or adverse modification of a designated or proposed critical habitat. The BLM will not approve any ground-disturbing activity that may affect any such species or critical habitat until it completes its obligations under applicable requirements of the Endangered Species Act as amended, 16 USC § 1531 et seq., including completion of any required procedure for conference or consultation.

Lease Stipulations that Apply in Biologically Sensitive Areas:

K-1 Lease Stipulation - Rivers

Objective: Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas; the loss of spawning, rearing or over-wintering habitat for fish; the loss of cultural and paleontological resources; the loss of raptor habitat; impacts to subsistence cabin and campsites; the disruption of subsistence activities; and impacts to scenic and other resource values.

Requirement/Standard: Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited in the streambed and adjacent to the rivers listed below at the distances identified. With the exception of the Ikpikpuk River, these setbacks are measured from the bank of the river as determined by the hydrology at the time of application. The standard setback is ½ mile (from the bank's highest high water mark) and increased to ¾ mile (from the bank's highest high water mark) where subsistence cabin and campsites are numerous. Along the Colville River and a portion of the Ikpikpuk a 1-mile (from the bank's highest high water mark) setback is required to protect important raptor habitat (for locations along rivers where setback distances change). On a case-by case basis, and in consultation with federal, state, and NSB regulatory and resource agencies (as appropriate, based on agency legal authority and jurisdictional responsibility), essential pipeline and road crossings to the main channel will be permitted through setback areas. The above setbacks may not be practical within river deltas. In these situations, permanent facilities shall be designed to withstand a 200-year flood event.

a. **Colville River**: a 1-mile setback from the northern bluff (or bank if there is no bluff) of the Colville River extending the length of that portion of the river located within the Planning Area. Note: The Planning Area excludes conveyed Native lands along the lower reaches of the Colville River. Development of road crossings intended to support oil and gas activities shall be consolidated with other similar projects and uses to the maximum extent possible. Note: This provision does not apply to intercommunity or other permanent roads constructed with public funds for general transportation purposes. This preserves the opportunity to plan, design, and construct public transportation systems to meet the economic, transportation, and public health and safety needs of the State of Alaska and/or communities within National Petroleum Reserve - Alaska.

b. **Ikpikpuk River**: a ¾-mile setback from each side of the centerline (1½ miles total) of the Ikpikpuk River extending from the mouth south to Sec. 19, T. 7 N., R. 11 W., U.M. (Umiat Meridian). From Sec. 19, T. 7 N., R. 11 W., U.M., to Sec. 4, T. 3 N., R. 12 W., U.M., a 1-mile setback is required. Beginning at Sec. 4, T. 3 N., R. 12 W., U.M., a ½-mile setback from the centerline (1 mile total) will be required to the confluence of the Kigalik River and Maybe Creek. Note: The setback distances only apply to the east bank where the Ikpikpuk River is the Planning Area boundary.

c. **Miguakiak River**: a ½-mile setback from the bank's highest high water mark.

d. **Kikiakrorak and Kogosukruk Rivers**: Note: The following discussion refers only to portions of the Kikiakrorak River downstream from T. 2 N., R. 4 W., U.M. and the Kogosukruk River (including the four tributaries off the southern bank) downstream from T. 2 N., R. 3 W., U.M.. No permanent oil and gas surface facilities, except essential transportation crossings, would be allowed within 1 mile of the top of the bluff (or bank if there is no bluff) on either side of the rivers and several of the Kogosukruk tributaries.

e. **Fish Creek**: No permanent oil and gas surface facilities, except essential transportation crossings, would be allowed within 3 miles (from the bank's highest high water mark) of the creek downstream from the eastern edge of Sec. 31, T. 11 N., R. 1 E., U.M. or within ½ mile (from the bank's highest high water mark) of the creek farther upstream.

f. **Judy Creek**: a ½-mile setback from the banks' highest high water mark extending from the mouth to the confluence of an unnamed tributary in Sec. 8, T8N., R.2W., Umiat Meridian.
g. **Tingmiaksiqvik River**: No permanent oil and gas surface facilities, except essential transportation crossings, would be allowed within ½ mile (from the bank's highest high waster mark) of this river from its headwaters within Sec. 13, T. 7 N., R. 1 W., U.M. downstream to its confluence with Fish Creek.

K-2 Lease Stipulation--Deep Water Lakes
Objective: Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of deep water lakes; the loss of spawning, rearing or over wintering habitat for fish; the loss of cultural and paleontological resources; impacts to subsistence cabin and campsites; and the disruption of subsistence activities.
Requirement/Standard: Generally, permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited on the lake or lakebed and within ¼ mile of the ordinary high water mark of any deep lake as determined to be in lake zone III (i.e., depth greater than 13 feet [4 meters]; Mellor 1985). On a case-by-case basis in consultation with Federal, State and NSB regulatory and resource agencies (as appropriate based on agency legal authority and jurisdictional responsibility), essential pipeline(s), road crossings, and other permanent facilities may be considered through the permitting process in these areas where the lessee can demonstrate on a site-specific basis that impacts will be minimal and if it is determined that there is no feasible or prudent alternative.

K-3 Stipulation - Teshekpuk Lake Shoreline
(Note: Teshekpuk Lake (approximately 211,000 acres) will be deferred from additional oil and gas leasing.)
Objective: Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of this large and regionally significant deep water lake; the loss of cultural and paleontological resources; impacts to subsistence cabins, campsites and associated activities; and to protect fish and wildlife habitat including important insect relief areas.
Requirement/Standard: Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited within ¼ mile of the ordinary high water mark of Teshekpuk Lake. (No alternative procedures will be approved.)

K-4 Lease Stipulation - Goose Molting Area
Objective: Minimize disturbance to molting geese and loss of goose molting habitat in and around lakes in the Goose Molting Area.
Requirement/Standard (General): Within the Goose Molting Area no permanent oil and gas facilities, except for pipelines will be allowed on the approximately 240,000 acres of lake buffers illustrated in lavender on Map 2-5. No alternative procedures will be considered. Prior to the permitting of a pipeline in the Goose Molting Area, a workshop will be convened to determine the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources. The workshop participants will include but will not be limited to Federal, State, and NSB representatives. In addition, only "In Field" roads will be authorized as part of oil and gas field development.
Requirement/Standard (Exploration): In goose molting habitat area exploratory drilling shall be limited to temporary facilities such as ice pads, ice roads, and ice airstrips, unless the lessee demonstrates that construction of permanent facilities (outside the identified Goose Molting Restricted Surface Occupancy Areas) such as gravel airstrips, storage pads, and connecting

roads is environmentally preferable (Also see *Stipulation K-11* regarding allowable surface disturbance). In addition, the following standards will be followed for permitted activities:

a. From June 15 through August 20 exploratory drilling and associated activities are prohibited. The intent of this rule is to restrict exploration drilling during the period when geese are present.

b. Water extraction from any lake used by molting geese shall not alter hydrological conditions that could adversely affect identified goose-feeding habitat along lakeshore margins. Considerations will be given to seasonal use by operators (generally in winter) and geese (generally in summer), as well as recharge to lakes from the spring snowmelt.

c. Oil and gas exploration activities will avoid alteration (e.g., damage or disturbance of soils, vegetation, or surface hydrology) of critical goose-feeding habitat types along lakeshore margins (grass/sedge/moss), as identified by the AO in consultation with the USFWS.

<u>Requirement/Standard (Development)</u>: In Goose Molting Area, the following standards will be followed for permitted activities:

a. Within the Goose Molting Area from June 15 through August 20, all off-pad activities and major construction activities using heavy equipment (e.g., sand/gravel extraction and transport, pipeline and pad construction, but not drilling from existing production pads) shall be suspended (see also Lease Stipulation K-5-d), unless approved by the AO in consultation with the appropriate Federal, State, and NSB regulatory and resource agencies. The intent of this requirement is to restrict activities that will disturb molting geese during the period when geese are present.

b. Water extraction from any lakes used by molting geese shall not alter hydrological conditions that could adversely affect identified goose-feeding habitat along lakeshore margins. Considerations will be given to seasonal use by operators (generally in winter) and geese (generally in summer), as well as recharge to lakes from the spring snowmelt.

c. Oil and gas activities will avoid altering (i.e.., damage or disturbance of soils, vegetation, or surface hydrology) critical goose-feeding habitat types along lakeshore margins (grass/sedge/moss) and salt marsh habitats.

d. Permanent oil and gas facilities (including gravel roads, pads, and airstrips, but excluding pipelines) and material sites will be sited outside the identified buffers and RSO areas. Additional limits on development footprint apply; (also see Lease Stipulation K-11.)

e. Between June 15 and August, 20 within the Goose Molting Area, oil and gas facilities shall incorporate features (e.g., temporary fences, siting/orientation) that screen/shield human activity from view of any Goose Molting Area lake, as identified by the AO in consultation with appropriate Federal, State, and NSB regulatory and resource agencies.

f. Strategies to minimize ground traffic shall be implemented from June 15 through August 20. These strategies may include limiting trips, use of convoys, different vehicle types, etc. to the extent practicable. The lessee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation. The vehicle use plan shall also include a vehicle-use monitoring plan. Adjustments will be required by the AO if resulting disturbance is determined to be unacceptable.

g. Within the Goose Molting Area, between June 15 and August 20, aircraft use (including fixed wing and helicopter) shall be restricted from June 15 through August 20 unless doing so endangers human life or violates safe flying practices. Restrictions may include: 1) limiting flights to two round-trips/week, and 2) limiting flights to corridors established by the BLM after discussions with appropriate Federal, State, and NSB regulatory and resource agencies. The lessee shall submit with the development proposal an aircraft use plan that considers these and other mitigation. The aircraft use plan shall also include an aircraft monitoring plan. Adjustments, including perhaps suspension of all aircraft use, will be required by the AO if resulting disturbance is determined to be unacceptable. Note: This site-specific lease stipulation is not intended to restrict flights necessary to survey wildlife to gain information

necessary to meet the stated objective of this lease stipulation. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.

h. Any permit for development issued under this IAP/EIS will include a requirement for the lessee to conduct monitoring studies necessary to adequately determine consequences of development and any need for change to mitigations. Monitoring studies will be site- and development-specific within a set of over-arching guidelines developed by the BLM after conferring with appropriate Federal, State, NSB agencies. The study(s) will include the construction period and will continue for a minimum of 3 years after construction has been completed and production has begun. The monitoring studies will be a continuation of evaluating the effectiveness of the K-4 Lease Stipulation requirements in meeting the objective of K-4 and determine if any changes to the lease stipulation or any project specific mitigation(s) are necessary. If changes are determined to be necessary, the BLM, with the lessee and/or their representative, will conduct an assessment of the feasibility of altering development operation (e.g. reduced human activity, visibility barriers, noise abatement). Any changes determined necessary will be implemented prior to authorization of any new construction.

K-5 Lease Stipulation - Teshekpuk Lake Caribou Habitat Area

<u>Objective</u>: Minimize disturbance and hindrance of caribou, or alteration of caribou movements through portions the Teshekpuk Lake Caribou Habitat Area that are essential for all season use, including calving and rearing, insect-relief, and migration.

<u>Requirement/Standard</u>: In the Teshekpuk Lake Caribou Habitat Area the following standards will be applied to permitted activities:

a. Before authorization of construction of permanent facilities (limited as they may be by RSO areas established in other lease stipulations), the lessee shall design and implement and report a study of caribou movement unless an acceptable study(s) specific to the Teshekpuk Lake Caribou Herd (TLCH) has been completed within the last 10 years. The study shall include a minimum of four years of current data on the TLCH movements and the study design shall be approved by the AO in consultation with the appropriate Federal, State, and NSB wildlife and resource agencies. The study should provide information necessary to determine facility (including pipeline) design and location. Lessees may submit individual study proposals or they may combine with other lessees in the area to do a single, joint study for the entire TLCHA. Study data may be gathered concurrently with other activities as approved by the AO and in consultation with the appropriate Federal, State, and NSB wildlife and resource agencies. A final report of the study results will be prepared and submitted. Prior to the permitting of a pipeline in the TLCHA, a workshop will be convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife (specifically the TLCH) and subsistence resources. The workshop participants will include but will not be limited to Federal, State, and NSB representatives. All of these modifications will increase protection for caribou and other wildlife that utilize the TLCHA during all seasons.

b. Within the TLCHA, lessees shall orient linear corridors when laying out oil field developments to the extent practicable, to address migration and corralling effects and to avoid loops of road and/or pipeline that connect facilities.

c. Ramps over pipelines, buried pipelines, or pipelines buried under the road may be required by the AO, after consultation with appropriate Federal, State, and NSB regulatory and resource agencies, in the TLCHA where pipelines potentially impede caribou movement.

d. Major construction activities using heavy equipment (e.g., sand/gravel extraction and transport, pipeline and pad construction, but not drilling from existing production pads) shall be suspended within TLCHA from May 20 through August 20, unless approved by the AO in consultation with the appropriate Federal, State, and NSB regulatory and resource agencies. The intent of this requirement is to restrict activities that will disturb caribou during calving

and insect-relief periods. If caribou arrive on the calving grounds prior to May 20, major construction activities will be suspended. The lessee shall submit with the development proposal a "stop work" plan that considers this and any other mitigation related to caribou early arrival. The intent of this latter requirement is to provide flexibility to adapt to changing climate conditions that may occur during the life of fields in the region.

e. The following ground and air traffic restrictions shall apply to permanent oil and gas-related roads in the areas and time periods indicated:

1. Within the TLCHA, from May 20 through August 20, traffic speed shall not exceed 15 miles per hour when caribou are within ½ mile of the road. Additional strategies may include limiting trips, using convoys, using different vehicle types, etc., to the extent practicable. The lessee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation. The vehicle use plan shall also include a vehicle-use monitoring plan. Adjustments will be required by the AO if resulting disturbance is determined to be unacceptable.
2. The lessee or a contractor shall observe caribou movement from May 20 through August 20, or earlier if caribou are present prior to May 20. Based on these observations, traffic will be stopped temporarily to allow a crossing by 10 or more caribou. Sections of road will be evacuated whenever an attempted crossing by a large number of caribou appears to imminent. The lessee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation. The vehicle use plan shall also include a vehicle-use monitoring plan. Adjustments will be required by the AO if resulting disturbance is determined to be unacceptable.
3. Major equipment, materials, and supplies to be used at oil and gas work sites in the TLCHA shall be stockpiled prior to or after the period of May 20 through August 20 to minimize road traffic during that period.
4. Use of aircraft larger than a Twin Otter by authorized users of the Planning Area, including oil and gas lessees, from May 20 through August 20 within the TLCHA, shall be for emergency purposes only. The lessee shall submit with the development proposal an aircraft use plan that considers these and other mitigation. The aircraft use plan shall also include an aircraft monitoring plan. Adjustments, including perhaps suspension of all aircraft use, will be required by the AO if resulting disturbance is determined to be unacceptable. This lease stipulation is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objective of this lease stipulation. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.
5. Fixed-wing aircraft takeoffs and landings by authorized users of the Planning Area shall be limited to an average of one round-trip flight per day from May 20 through June 20, at aircraft facilities within the TLCHAs. The lessee shall submit with the development proposal an aircraft use plan that considers these and other mitigation. The aircraft use plan shall also include an aircraft monitoring plan. Adjustments, including perhaps suspension of all aircraft use, will be required by the AO if resulting disturbance is determined to be unacceptable.
6. Aircraft shall maintain a minimum height of 1,000 feet AGL (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1, and 2,000 feet AGL over the TLCHA from May 20 through August 20, unless doing so endangers human life or violates safe flying practices. Caribou wintering ranges will be defined annually by the AO in consultation with the Alaska Department of Fish and Game.

K-6 Stipulation - Coastal Area
Objective: Minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas; to prevent contamination of marine waters; loss of important bird habitat; alteration or disturbance of shoreline marshes; and impacts to subsistence resources activities.
Requirement/Standard: In the Coastal Area, permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines established to support exploration and development activities shall be located at least ¾ mile inland from the coastline to the extent practicable. Where, as a result of technological limitations, economics, logistics, or other factors, a facility must be located within ¾ mile inland of the coastline, the practicality of locating the facility at previously occupied sites such as Camp Lonely, various Husky/USGS drill sites, and Distant Early Warning (DEW)-Line sites, shall be considered. Use of existing sites within ¾ mile of the coastline shall also be acceptable where it is demonstrated that use of such sites will reduce impacts to shorelines or otherwise be environmentally preferable. All lessees/permitees involved in activities in the immediate area must coordinate use of these new or existing sites with all other prospective users. Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission, the Nuiqsut Whaling Captains' Association, and the NSB to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope.

K-7 Lease Stipulation - Colville River Special Area
Objective: Prevent or minimize loss of raptor foraging habitat. (also see Lease Stipulation K-1; Rivers Area).
Requirement/Standard for Facilities: If necessary to construct permanent facilities within the Colville River Special Area, all reasonable and practicable efforts shall be made to locate permanent facilities as far from raptor nests as feasible. Within 15 miles of raptor nest sites, significant alteration of high quality foraging habitat shall be prohibited unless the lessee can demonstrate on a site-specific basis that impacts would be minimal or it is determined that there is no feasible or prudent alternative. Of particular concern are ponds, lakes, wetlands, and riparian habitats. Note: On a case-by case basis, and in consultation with appropriate federal and state regulatory and resource agencies, essential pipeline and road crossings will be permitted through these areas where no other feasible or prudent options are available.
Requirement/Standard for Activities: Restriction applies to overland moves, seismic work, and any similar use of heavy equipment (other than actual excavations as part of construction) on tundra surfaces.

K-8 Lease Stipulation - Pik Dunes
Objective: Retain unique qualities of the Pik Dunes, including geologic and scenic uniqueness, insect-relief habitat for caribou, and habitat for several uncommon plant species.
Requirement/Standard: Surface structures, except approximately perpendicular pipeline crossings and ice pads, are prohibited within the Pik Dunes.

K-9 Lease Stipulation – Caribou Movement Corridor
Objective: Minimize disturbance and hindrance of caribou, or alteration of caribou movements (that are essential for all season use, including calving and rearing, insect-relief, and migration) in the area extending from the eastern shore of Teshekpuk Lake to approximately 6 miles eastward towards the Kogru Inlet and 2) the area adjacent to the northwest corner of Teshekpuk Lake.
Requirement/Standard: Within the Caribou Movement Corridors, no permanent oil and gas facilities, except for pipelines, will be allowed on the approximately 54,700 (approximately 45,000 acres east of Teshekpuk Lake, and approximately 9,700 acres northwest of Teshekpuk Lake) illustrated on Map 2-4. Prior to the permitting of a pipeline in the Caribou Movement

Corridors, a workshop will be convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources. The workshop participants will include but will not be limited to Federal, State, and NSB representatives. Note: In addition to the general lease stipulations and ROPs, site-specific lease stipulations, i.e. K-3, K-4, K-5, and K-11 will also apply.

K-10 Lease Stipulation – Southern Caribou Calving Area
Objective: Minimize disturbance and hindrance of caribou, or alteration of caribou movements (that are essential for all season use, including calving and post calving, and insect-relief) in the area south/southeast of Teshekpuk Lake:
Requirement/Standard: Within the Southern Caribou Calving Area, no permanent oil and gas facilities, except pipelines, would be allowed on the approximately 233,000 acres illustrated on Map 2-4. Note: In addition to the general stipulations and ROPs, site specific *Stipulations K-4, K-5, K-6, and K-11* would also apply.

K-11 Lease Stipulation: Lease Tracts A-G
Objective: To protect key surface resources and subsistence resources/activities resulting from permanent oil and gas development and associated activities.
Requirement Standard: Permanent surface disturbance resulting from oil and gas activities is limited to 300 acres within the following described lease tracts (Map 2-4); this does not include surface disturbance activities from pipeline construction. Existing gravel pads within these tracts would not count against the 300-acre limit. A pipeline will be considered after a workshop is convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources. The workshop participants will include but will not be limited to Federal, State, and NSB representatives. (No alternative procedures will be approved). (Acreages are based on GIS calculations and are approximate):

A. Total Acreage: approximately 49,000:
- 39,400 acres = RSO for Permanent Oil and Gas facilities excluding pipelines (the 23,350 acres includes 5,605 acres of overlap with the Coastal area restrictions).
- 9,600 acres = Area open to development subject to general and site specific lease stipulations and required operating procedures.

The total new development footprint cannot exceed 300 acres (0.6 % of total acreage) within the approximately 41,400 acres available for surface occupancy.

B. Total Acreage: approximately 45,900:
- 40,700 acres = RSO for Permanent Oil and Gas facilities, excluding pipelines (the 33,478 acres includes 5,131 acres of overlap with the Coastal Area restrictions).
- 5,200 acres = Area open to development subject to general and site specific lease stipulations and required operating procedures.

The total new development footprint cannot exceed 300 acres (0.6 % of total acreage) within the 5,200 acres available for surface occupancy.

C. Total Acreage: approximately 53,500:
- 48,800 acres = RSO for Permanent Oil and Gas facilities, excluding pipelines.
- 4,700 acres = Area open to development subject to general and site specific lease stipulations and required operating procedures.

The total new development footprint cannot exceed 300 acres (0.7 % of total acreage) within the 18,399 acres available for surface occupancy.

D. Total Acreage: approximately 51,700:
- 29,100 acres = RSO for Permanent Oil and Gas facilities excluding pipelines.
- 22,600 acres = Area open to development subject to general and site specific lease stipulations and required operating procedures.

The total new development footprint cannot exceed 300 acres (0.5% of total acreage) within the 22,600 acres available for surface occupancy.

E. Total Acreage: approximately 56,800:
- 47,000 acres = RSO for Permanent Oil and Gas facilities, excluding pipelines.
- 9,800 acres = Area open to development subject to general and site specific lease stipulations and required operating procedures.

The total new development footprint cannot exceed 300 acres (0.6% of total acreage) within the 9,800 acres available for surface occupancy.

F. Total Acreage: approximately 58,000:
- 46,400 acres = RSO for Permanent Oil and Gas facilities, excluding pipelines.
- 4,900 acres = Restricted area open to development subject to the results of 3 year study requirement to determine appropriate placement of permanent facility(s) (Map 2-5)
- 6,700 acres = Area open to development subject to general and site specific lease stipulations and required operating procedures.

The total new development footprint cannot exceed 300 acres (0.5 % of total acreage).

G. Total Acreage: approximately 58,000:
- 46,400 acres = RSO for Permanent Oil and Gas facilities excluding pipelines
- 300 acres = Restricted area open to development subject to the results of 3 year study requirement to determine appropriate placement of permanent facility(s) (Map 2-5)
- 11,300 acres = Area open to development subject to general and site specific lease stipulations and required operating procedures.

The total new development footprint cannot exceed 300 acres (0.5 % of total acreage)

Summer Vehicle Tundra Travel:

L-1 Required Operating Procedure

Objective: Protect stream banks and water quality; minimize compaction and displacement of soils; minimize the breakage, abrasion, compaction, or displacement of vegetation; protect cultural and paleontological resources; maintain populations of, and adequate habitat for birds, fish, and caribou and other terrestrial mammals; and minimize impacts to subsistence activities.

Requirement/Standard: On a case-by-case basis, BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during times other than those identified in ROP C-2a. Permission for such use would only be granted after an applicant has:

a. Submitted studies satisfactory to the AO of the impacts on soils and vegetation of the specific low-ground-pressure vehicles to be used. These studies should reflect use of such vehicles under conditions similar to those of the route proposed for use and should demonstrate that the proposed use would have no more than minimal impacts to soils and vegetation.

b. Submitted surveys satisfactory to the AO of subsistence uses of the area as well as of the soils, vegetation, hydrology, wildlife and fish (and their habitats), paleontological and archaeological resources, and other resources as required by the AO.

c. Designed and/or modified the use proposal to minimize impacts to the AO's satisfaction. Design steps to achieve the objectives and based upon the studies and surveys may include, but not be limited to, timing restrictions (generally it is considered inadvisable to conduct tundra travel prior to August 1 to protect ground-nesting birds), shifting of work to winter, rerouting, and not proceeding when certain wildlife are present or subsistence activities are occurring. At the discretion of the AO, the plan for summer tundra vehicle travel may be included as part of the spill prevention and response contingency plan required by 40 CFR 112 (Oil Pollution Act) and ROP A-4.

Appendix G: Examples of Public Health Mitigation Strategies

APPENDIX G

EXAMPLES OF PUBLIC HEALTH MITIGATION STRATEGIES

Appendix G

Examples of Public Health Mitigation Strategies

The following are examples of strategies for mitigating the impacts of industrial development on public health using the "social determinants of health" framework which have been implemented successfully elsewhere. This discussion is provided by BLM and NSB as a guide to measures which could be adapted for use in the North Slope. The measures included do not represent an exhaustive list. Instead, they are intended as pertinent examples of measures that might be successfully adapted to meet the needs of the affected North Slope communities, in order to mitigate impacts discussed in this IAP/EIS.

Economic and sociocultural conditions are among the most powerful drivers of health and health disparities, particularly in minority and indigenous communities. Internationally, this principle has become a central focus in industrial development and finance efforts. The following organizations have taken a leading role in advocating for a model of development planning which takes full account of the socioeconomic and health effects of development on indigenous and ethnic minority communities, and have published guidelines addressing these issues:

- The World Bank – Operational Policy 4.10, "Indigenous Peoples," at http://wbln0018.worldbank.org/Institutional/Manuals/OpManual.nsf/tocall/0F7D6F3F04DD70398525672C007D08ED?OpenDocument
- The International Association of Oil and Gas Producers – "A Guide to Health Impact Assessments in the Oil and Gas Industry," at www.ipieca.org/downloads/health/**hia**/**HIA**.pdf
- Royal Dutch/Shell Health, Safety, and Environment Panel – "Impact Assessment"
- The signatories to the Equator Principals, at www.**equator-principles**.com/
- International Association of Impact Assessment – "Health Impact Assessment: International Best Practice Principles" http://www.iaia.org/modx/assets/files/SP5.pdf

The principles and measures outlined here could be adapted, through a process of community consultation, to meet the goals of a "Healthy Neighbors" plan, thus creating a comprehensive and effective strategy for long-term management of the sociocultural, economic, and public health changes discussed in this IAP/EIS.

1. Infectious Disease Prevention:
   Examples/Precedents:
   a. Shell Camisea[1] Project: Shell's initial oil exploration program in the 1980s was heavily criticized in large part because of epidemics of infectious diseases that

[1] May P, Dabbs A, et al (1999) Corporate Roles and Rewards in Promoting Sustainable Development: Lessons Learned from Camisea. Energy and Resources Group, U.C. Berkeley. Berkeley, CA. Accessed online on March 23, 2007 at http://socrates.berkeley.edu/erg/documents/camisea.pdf

occurred in the indigenous communities after contact with outside oil workers. As a result, Shell consulted with a highly qualified team of scientists and developed a number of interventions to prevent infections. Interventions used included:

- Construction of camps which were physically segregated from the indigenous communities.
- Strict controls on when and how employees were allowed to enter Native villages.
- A requirement for a "health passport," in which employees were extensively vaccinated and routinely screened for communicable diseases.
- Roadless construction, to prevent entry to the communities by other outside groups or individuals; and strict monitoring and control of employee contact with the indigenous community.

b. Chad-Cameroon Pipeline: a Health Impact Assessment of this project, done as a requirement for financing set out by the World Bank, revealed the potential that truckers from an area of high-prevalence HIV would trigger an epidemic of HIV in a region of low-prevalence HIV. An intervention involving a relay system, in which workers would drive within their own geographic regions, and relay trucks to drivers in the next region, was designed to prevent transmission.[2]

2. Interaction between outside workforce and local indigenous community:
Recognizing that a large influx of outside workers into a small indigenous community may lead social and cultural conflict and tension (related to issues including acculturation, tensions between work and subsistence, intra-generational conflicts as children adopt modes of behavior and communication mirroring the outside society, and importation of drugs and alcohol), developers in other regions have developed protocols to control interaction between workers and the community. Measures include restricting entry by industry employees to local communities, building camps and facilities separate from communities, and banning or restricting the construction of roads into communities. See Shell's Camisea project and the Chad-Cameroon Pipeline as examples.

3. Support of subsistence:
Substantial impacts to subsistence – both harvest amounts and dietary intake – are possible under development scenarios resulting from leasing in the planning area. Subsistence foods constitute the primary protection against diabetes and metabolic syndromes (epidemic problems in other American Indian Tribes), food insecurity and hunger. Furthermore, subsistence activities form the foundations of cultural stability and therefore important protections against social pathology. Suitable "replacement foods" are not available: there is no nutritionally equivalent food available for purchase

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[2] Leonard L (2003) Possible illnesses: assessing the health impacts of the Chad Pipeline Project. Bulletin of the World Health Organization 2003; 81: 427-433. Accessed online on March 24, 2007 at http://www.hiagateway.org.uk/media/hiadocs/HIA_Leonard.pdf.
Jobin, W (2003) Health and Equity Impacts of a large oil project in Africa. Bulletin of the World Health Organization. 81: 420-426

in local or regional stores. Furthermore, studies have documented the generally poor nutritional value of store-bought foods available in rural Alaskan villages.

Examples/Precedents:
A variety of programs have been used to support subsistence lifestyles and diets, and healthful alternate foods in northern indigenous communities facing the impacts of industrialization

a. Hunter Support programs: in general, these programs provide financial support for hunters, in return for efforts to hunt for the community. Programs have taken many forms, including support for poor families to purchase gas and equipment, and financial compensation for time spent hunting for community members[3]
b. Community freezers: the construction of community freezers would facilitate storage of harvested resources for longer periods of time, allowing a more even supply of foods available to the community.
c. Work Schedule modifications: flexible work schedules, subsistence leave, and job-sharing options may facilitate continued active participation in subsistence while allowing communities to reap the benefits of employment opportunity.

4. Healthy Diet interventions:
If development results in declining intake of subsistence foods (either because of impacts to the availability of resources, more difficult hunting conditions, or because of sociocultural change), North Slope communities will be at increased risk for diabetes, hypertension, hypercholesterolemia, and the resultant increases in cardiovascular and cerebrovascular diseases. The nutritional value of foods in northern village stores is generally quite poor, and people often chose "junk" foods such as chips, sweets, and soft drinks because of the relatively lower cost of these caloric sources. There are evidence-based measures which can support healthy dietary choices with regard to store-bought foods.

Examples/Precedents

a. Johns Hopkins Healthy Stores Program: employs community-directed participatory research to identify barriers to healthy eating, and creates incentives for local stores to stock better food choices. This program has been extensively validated in several indigenous communities, and is currently being piloted with encouraging initial results in Nunavut, Canada.[4]
b. Food Mail: the government of the Northwest Territories reduced the postage rate for "Nutritious Perishable Food" to encourage families to utilize regional sources of more nutritious store-bought foods.[5]

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[3] Chan H, Fediuk K et al. Food Security in Nunavut, Canada: Barriers and Recommendations. International Journal of Circumpolar Health. 65(5) 416-431
Aarluk Consulting Inc (2006) A consultation-based review of the harvester support programs of the Government of Nunavut and NunavutTunngavik Inc.
[4] Ho L, Gittelsohn S et al. Development of an integrated diabetes prevention program with First Nations in Canada. Health Promotion International 21(2) 88-97
[5] Indian and Northern Affairs Canada. Food Mail Program Brochure. Online at http://www.ainc-inac.gc.ca/ps/nap/air/1brofoomai_e.html
Indian and Northern Affairs Canada. Backgrounder: Food mail program. Online at http://www.ainc-inac.gc.ca/nr/prs/s-d2001/01253bk_e.html

5. Economic Sustainability and Sociocultural Impacts:
The "boom and bust" economic cycle (rapid and dramatic economic growth followed by economic depression) that may accompany natural resource development in indigenous communities can create large-scale social and cultural change, and worsen social pathology such as alcohol and substance abuse, domestic violence, and suicide.

Examples/Precedents

a. Sakhalin II development: Indigenous Minorities Development Plan:
A plan which assessed the likely socioeconomic effects of planned development on the local indigenous community, and developed and funded a mitigation package targeted at minimizing adverse social and economic outcomes, maximizing potential benefits, and promoting sustainable economic development. Based in part on World Bank OD 4.20 (an older version of OP 4.10). It provides a portfolio of interventions including:
    - Business training, start-up support for local businesses
    - Health services funding
    - Education support, including scholarships for professional training, stipends for low-income students
    - Financial support for cultural activities
    - Leadership capacity-building: training seminars, computer equipment

b. Economic sustainability through "sustainable savings and investment programs": for example, Canada's National Roundtable on the Environment and Economy reviewed resource development in northern indigenous communities and recommended the creation of savings and investment programs specifically targeting long-term fiscal stability for the impacted communities, as well as equitable distribution of the economic benefits of development within the communities such that projects do not create or exacerbate "have and have-not" problems within indigenous communities.[6]

c. Shell Camisea – development plan focused on sustainable development through building and supporting social capital:
    - In partnership with a regional NGO, developed a socio-economic assessment and plan for sustainable development.
    - Shell engaged the Smithsonian Institution's Conservation Biology Institute to prepare a biodiversity assessment and monitoring plan, and committed resources to ongoing monitoring, which drove an adaptive management strategy.
    - Investment strategy: strengthen existing local organizations (e.g. 'Mother's Clubs') which were able to fund and administer local projects.

Lawn J, Harvey D (2001) Change in nutrition and food security in two Inuit communities, 1992-1997. Minister of Public Works and Government Services Canada. Ottawa, Canada.

[6] National Roundtable on the Environment and the Economy (2005). Aboriginal Communities and Non-renewable Resource Development. Online at www.nrtee-trnee.ca/Publications/PDF/SOD_Aboriginal_E.pdf

Appendix H: Common, Scientific and Inupiaq Names of Species Listed in Supplemental IAP/EIS

APPENDIX H

COMMON, SCIENTIFIC, AND IÑUPIAQ NAMES OF SPECIES LISTED IN SUPPLEMENTAL IAP/EIS

Appendix H

COMMON, SCIENTIFIC, AND IÑUPIAQ NAMES OF SPECIES LISTED IN SUPPLEMENTAL IAP/EIS

Common Name	Scientific Name	Iñupiaq Name[1]
VEGETATION		
Small Trees and Shrubs		
Alpine blueberry	*Vaccinium uliginosum*	Subaq/asriavik/asiaq/asiavik
Cloudberry	*Rubus chamaemorus*	Aqpik
Crowberry	*Empetrum nigrum*	Paunbaq
Dwarf birch	*Betula nana* ssp. *exilis*	–
Lapland cassiope	*Cassiope tetragona*	Ikubutigiksut
Lingonberry	*Vaccinium vitis-idaea*	Kikmieeaq/kipmifnaq
Northern labrador tea	*Ledum palustre* ssp. *decumbens*	Tilaaqiaq
Mountain alder	*Alnus viridis* ssp. *crispa*	–
Grasses		
(unknown)	*Poa lanata*	–
Alkali grass	*Puccinellia phryganodes*	–
Alaska bluegrass	*Poa hartzii* ssp. *alaskana*	–
Pendent grass	*Arctophila fulva*	–
Polar grass	*Arctagrostis latifolia*	–
False semaphoregrass	*Pleuropogon sabinei*	–
Eurasian Junegrass	*Koeleria asiatica*	
Tufted hairgrass	*Deschampsia ceaspitosa*	–
Sedges		
Cottongrass	*Eriophorum angustifolium*	–
Cottongrass	*Eriophorum russeolum*	–
Tussock cottongrass	*Eriophorum vaginatum L.*	Maniq
Water sedge	*Carex aquatilis*	–
Wildflowers		
fewflower draba	*Draba pauciflora*	–
Drummond's bluebell	*Mertensia drummondii*	–
Fireweed	*Epilobium latifolium*	Quppiqutaq
Marsh fivefinger	*Potentilla palustris*	–
Marsh marigold	*Caltha palustris*	–

Common Name	Scientific Name	Iñupiaq Name[1]
Pygmy aster	*Aster pygemaeus*	–
Scurvy grass	*Cochlearia officianalis*	–
Stipulated cinquefoil	*Potentilla stipularis*	–
Sweet coltsfoot	*Petasites frigidus*	–
FISH		
Freshwater Species		
Alaska blackfish	*Dallia pectoralis*	Iłuuqiniq
Arctic char	*Salvelinus alpinus*	—
Arctic grayling	*Thymallus arcticus*	Sulukpaugaq
Burbot	*Lota lota*	Tittaaliq
Lake trout	*Salvelinus namaycush*	Iqaluaqpak
Longnose sucker	*Catostomus catostomus*	Milugiaq
Ninespine stickleback	*Pungitius pungitius*	Kakalisaauraq
Northern pike	*Esox lucius*	Siulik
Round whitefish	*Prosopium cylindraceum*	Savigunnaq
Slimy sculpin	*Cottus cognatus*	Kanayuq
Threespine stickleback	*Gasterosteus aculatus*	—
Anadromous Species		
Arctic cisco	*Coregonus autumnalis*	Qaataq
Arctic lamprey	*Lampetra japonica*	Nimigiaq
Bering cisco	*Coregonus laurettae*	Tiipuq
Chinook (king) salmon	*Oncorhynchus tschawytscha*	—
Chum salmon	*Oncorhynchus keta*	Iqalugruaq
Pink salmon	*Oncorhynchus gorbuscha*	Amaqtuuq
Rainbow smelt	*Osmerus mordax*	Iłhauġniq
Sockeye (red) salmon	*Oncorhynchus nerka*	—
Amphidromous Species[2]		
Broad whitefish	*Coregonus nasus*	Aanaaqłiq
Dolly varden	*Salvelinus malma*	Iqalukpik
Humpback whitefish	*Coregonus pidschian*	Piquktuuq
Least cisco	*Coregonus sardinella*	Iqalusaaq
Marine Species		
Arctic cod	*Boregogadus saida*	Uugaq
Arctic flounder	*Liopsetta glacialis*	Nataaġnaq/Puyyagiaq
Capelin	*Mallotus villosus*	Panmigriq
Fourhorn sculpin	*Myoxocephalus quadricornus*	Kanayuq
Kelp snailfish	*Liparis tunicatus*	—
Pacific herring	*Clupea harengus*	Uqsruqtuuq
Pacific sandlance	*Ammodytes hexapterus*	—

Common Name	Scientific Name	Iñupiaq Name[1]
Saffron cod	*Eleginus gracilis*	Uugaq
Arctic cod	*Boregogadus saida*	Uugaq
BIRDS		
Seabirds		
Arctic tern	*Sterna paradisea*	Mitqutailxaq
Black guillemot	*Cepphus grylle*	Ifabiq
Glaucous gull	*Larus hyperboreus*	Nauyavasrugruk
Long-tailed jaeger	*Stercorarius longicaudus*	Isuffaq
Parasitic jaeger	*Stercorarius parasiticus*	Mibiaqsaayuk
Pomarine jaeger	*Stercorarius pomarinus*	Isuffabluk
Sabine's gull	*Xema sabini*	Aqargigiaq
Loons		
Pacific loon	*Gavia pacifica*	Malbi
Red-throated loon	*Gavia stellata*	Qaksrauq
Yellow-billed loon	*Gavia adamsii*	Tuutlik
Waterfowl		
Brant	*Branta nigricans*	Niblinbaq
Canada goose	*Branta canadensis*	Iqsrabutilik
Common eider	*Somateria mollissima*	Amauligruaq
King eider	*Somateria spectabilis*	Qifalik
Lesser snow goose	*Anser caerulescens caerulescens*	–
Long-tailed duck	*Clangula hyemalis*	Aahaaliq
Northern pintail	*Anas acuta*	Kurugaq
Scaup	*Aythya* spp.	–
Scoter	*Melanitta* spp.	–
Spectacled eider	*Somateria fischeri*	Qavaasuk
Steller's eider	*Polysticta stelleri*	Igniqauqtuq
Tundra swan	*Cygnus columbianus*	–
White-fronted goose	*Anser albifrons*	Kigiyuk/niblivaixuk
Shorebirds		
American golden-plover	*Pluvialis dominica*	Tullik
Baird's sandpiper	*Erolia bairdii*	Puviaqtuuyaaq
Bar-tailed godwit	*Limosa lapponica*	Turraaturaq
Black-bellied plover	*Squatarola squatarola*	Tullikpak
Buff-breasted sandpiper	*Tryngites subruficollis*	Satqagiixaq
Dunlin	*Erolia alpina*	Siiyukpaligauraq
Long-billed dowitcher	*Linnodromus scolopaceus*	Siiyukpalik
Pectoral sandpiper	*Erolia melanotos*	Puviaqtuuq

Common Name	Scientific Name	Iñupiaq Name[1]
Red phalarope	*Phalaropus fulicarius*	Auksruaq
Red-necked phalarope	*Phalaropus lobatus*	–
Shorebirds (continued)		
Ruddy turnstone	*Arenaria interpres*	Tullignaq
Semipalmated sandpiper	*Ereunetes pusillus*	Livilivillakpak
Stilt sandpiper	*Micropalama griseus*	–
Raptors		
Bald eagle	*Haliaeetus leucocephalus*	Tifmiaqpak
Gyrfalcon	*Falco rusticolus*	–
Northern harrier	*Circus cyaneus*	Papiktuuq
Peregrine falcon	*Falco peregrinus*	Kirgavik
Rough-legged hawk	*Buteo lagapus*	Qixbiq
Short-eared owl	*Asio flammeus*	Nipaiouktaq/nipaixuktaq
Snowy owl	*Nyctea scandiaca*	Ukpik
Ptarmigan		
Willow Ptamigan	*Lagopus lagopus*	–
Rock ptarmigan	*Lagopus mutus*	Niqsaaqtufiq
Passerine		
Common raven	*Corvus corax*	Tulugaq
Lapand longspur	*Calcarius lapponicus*	Qupajuk/putukiijuk
Redpoll	*Acanthis spp.*	Saqsakiq
Savannah sparrow	*Passerculus sandwichensis*	Aanaruie suliuqpa
Snow bunting	*Plectrophenax nivalis*	Amautligaq/avatalibuuvaq/ amautlikkauraq/amaujigaalu k
MAMMALS		
Large Mammals		
Arctic fox	*Alopex lagopus*	Qusrhaaq/tibiganniaq/qujha aq
Caribou	*Rangifer tarandus*	Tuttu
Dall sheep	*Ovis dalli dalli*	Imnaiq/ipnaiq
Gray wolf	*Canis lupus*	Amabuq
Grizzly (brown) bear	*Ursus arctos*	Akjaq
Lynx	*Lynx canadensis*	Niutuuyiq/niutuiyiq/nuutuu yiq
Moose	*Alces alces*	Tiniikaq/tuttuvak/tiniika
Muskox	*Ovibos moschatus*	Umifmak/imummak
Red fox	*Vulpes vulpes*	Kavviaq/kayuqtuq
Wolverine	*Gulo gulo*	Qavvik/qapvik

Common Name	Scientific Name	Iñupiaq Name[1]
Small Mammals		
Arctic ground squirrel	*Spermophilus parryii*	Siksrik
Barrenground shrew	*Sorex ugyunak*	–
Brown lemming	*Lemmus trimucronatus*	Aviffaq
Small Mammals (continued)		
Collared lemming	*Dicrostonyx groenlandicus*	Qixafmiutauraq
Ermine (short-tailed weasel)	*Mustela erminea*	Itibiaq/tibiaq
Least weasel	*Mustela nivalis*	–
Northern red-backed vole	*Clethrionomys rutilus*	–
Singing vole	*Microtus miurus*	Avieeaq
Snowshoe hare	*Lepus americanus*	Ukalliuraq/ukalliq
Tundra shrew	*Sorex tundrensis*	Ugrufnaq
Tundra vole	*Microtus oeconomus*	Avieeaq
Other Mammals		
Coyote	*Canis latrans*	Amabuuraq
Mink	*Mustela vison*	Tibiaqpak
Porcupine	*Erethizon dorsatum*	Ixuqutaq/qifabluk
River otter	*Lutra canadensis*	Pamiuqtuuq
Marine Mammals		
Bearded seal	*Erignathus barbatus*	Ugruk
Beluga whale	*Delphinapterus leucas*	Sisuaq/kilalugak
Bowhead whale	*Balaena mysticetus*	Abviq
Polar bear	*Ursus maritimus*	Nanuq
Ringed seal	*Phoca hispida*	Qaibulik/qaibutlik
Spotted seal	*Phoca largha*	Qasigiaq

[1] Iñupiaq names from web site edition of *Iñupiat Eskimo Dictionary*: [http://www.alaskool.org/language/dictionaries/inupiaq/dictionary.htm]. Accessed on April 22, 2004.
[2] Have some components of their populations that remain in freshwater year-round.
[3] Principal (most commonly caught) coastal fish only.

Appendix I: Historic Sites

APPENDIX I

HISTORIC SITES

APPENDIX I

DOCUMENTED ALASKA HERITAGE RESOURCE SERVICES SITES AND TRADITIONAL LAND USE INVENTORY SITES IN THE NORTHEAST NATIONAL PETROLEUM RESERVE – ALASKA

Table I-1. Documented Alaska Heritage Resource Services Sites

AHRS NO.	OTHER NO.[1]	SITE NAME	DESCRIPTION	DATE/PERIOD
Prehistoric				
HAR-002	NSB CRSI 2278	HAR-002	Scattered artifacts (e.g., flint spall, ground slate, cut antler, ivory harpoon dart head, bird bone). By 1980, site was destroyed by erosion.	Prehistoric
HAR-003		HAR-003	Isolated black chert flake, carved tent stake, pole.	Prehistoric
HAR-009		HAR-009	Isolated tan chert flake.	Prehistoric
HAR-047		HAR-047	Gray chert artifacts (e.g., tip/midsection of endblade (ASTt), flake core, retouched flake), scattered bones, bone fragments.	Prehistoric (ASTt)
HAR-050		HAR-050	Four black chert flakes.	Prehistoric
HAR-155	TLUI 63	UYAGAGVIIT (UYAGAGVIK)	Beach used as quarry for net weight stones, remains of wall tent/ wooden stakes - used for trapping, hunting, fishing, game lookout.	Prehistoric
HAR-169*	TLUI 58 & +6	NEGILIK (NILIK, NERLIK, NIRLIK, NECHELIK, WOODS' INAAT, WOODS CAMP)	Historic/prehistoric trading - smokehouse/drying rack, generator shed with motor, storage houses, the Woods' residence house, wood covered ice cellar, 3 graves, buildings belonging to the Helmericks, 4 sod house ruins, camp area (surface scatter of caribou bone, antler, fire-cracked rock, wood, bone and stone artifacts).	Prehistoric/Historic (AD 1930s-1940s)
IKR-058	ROS 78-005	IKR-058	Cranium of a large mammal with unassociated shotgun shell and candy bar wrappers nearby.	Prehistoric
IKR-073		IKR-073	A single chert waste flake.	Prehistoric
TES-002	ROS 78-011	PAPTAUN	Fishing and hunting camp (e.g., small firepits, bone, canvas cloth, tin cans, cut/sawn caribou antler, 2 chert flakes, cork float fragment, and caribou antler net sinker).	Prehistoric/Historic
TES-004		TES-004	A single chert flake.	Prehistoric
TES-005		TES-005	An isolated Putu-like projectile point base.	Prehistoric
TES-007		TES-007	Isolated chert flake.	Prehistoric
TES-008		TES-008	Isolated projectile point.	Prehistoric (Norton?)
TES-009		TES-009	Isolated flake knife.	Prehistoric (late ASTt – Norton/Ipiutak?)
TES-012		TES-012	Small scatter of lithics, including 12 flakes, a rough biface, and a projectile point or knife.	Prehistoric (Denbigh or ASTt?)

AHRS NO.	OTHER NO.[1]	SITE NAME	DESCRIPTION	DATE/PERIOD
TES-014		TES-014	Scattered cultural material from a large multicomponent site (e.g., microblades, obsidian point base, bullet, biface segment, projectile point fragment, pottery, arrowshaft base, quartzite hammerstone, debitage, walrus ivory, cracked caribou bone, flakes, recent debris).	Prehistoric/Historic
TES-015		TES-015	A wooden kayak/sled piece, 3 bone sled-shoe pieces (stone-drilled holes).	Prehistoric
TES-020		TES-020	Two rectangular sod house ruins, large sod meat cellar/storage facility. No historic items.	Prehistoric
TES-051			Microblade and weathered caribou bones.	Prehistoric
TES-054		T78-1	Chert flakes.	Prehistoric
TES-057		KEALOCK	Dark brown and black chert flakes.	Prehistoric (early Holocene)
UMI-001	Solecki 26	UMI-001	Approximately 10-15 waste flakes scattered over a wide area on a pronounced bench or knoll.	Prehistoric
UMI-002		UMI-002	Scattered artifacts (e.g., 20+ flakes - small blade-like flake fragments and bone fragments).	Prehistoric
UMI-003		UMI-003	Isolated side blade.	Prehistoric
UMI-004		UMI-004	Six waste flakes.	Prehistoric
UMI-005		UMI-005	Collapsed cairn and large flake scatter (e.g., 500+ flakes [sections of blade-like flakes/utilized flakes], bifaces and biface fragments).	Prehistoric
UMI-006	ROS78-003	UMI-006	Small lithic scatter (e.g., 25+ waste flakes/ utilized flakes, blade-like flake, 30.06 shell casing and caribou rack).	Prehistoric/Historic
			Historic	
HAR-004	TLUI 70	KITIK	Quarry for the material known as *kitik* ("pulverized stone"), a fine-grained volcanic ash used traditionally in skin processing. Important Inupiat traditional cultural property.	Historic
HAR-005			Sod house and boat.	Historic
HAR-006			Antler artifact and caribou bones on the beach at a drained lake.	Historic
HAR-007			Reindeer herding driftwood fence/tent platforms.	Historic
HAR-010		KIKKAQ	Wooden marker surrounded by cobbles that commemorates a favorite camping area.	Historic (AD 1970s)
HAR-011	TLUI 43 NSB CRSI 2241	SIKULIK	Subsistence camp - standing cabin, sod house pit, wood-covered ice cellar, and grave.	Historic to modern
HAR-012	TLUI 46 NSB CRSI 2244	AGKI	House, sod house pit (e.g., wall timbers, corner posts, floor boards/collapsed ceiling remains, reindeer bones, skulls, antlers topped by a yellow plastic wind survey disk, a fox trap, and scattered surface debris).	Historic (AD 1920s)
HAR-013	NSB CRSI A	UGUAK (OYAGAK)	House pits/sod house ruins, recent cabins, dog tether stakes, scattered surface historic artifacts (e.g., enameled "honey pot," Thermos bottle), and an ice cellar with an intact wooden entry frame.	Historic

AHRS NO.	OTHER NO.[1]	SITE NAME	DESCRIPTION	DATE/PERIOD
HAR-014	NSB CRSI 2279	HAR-014	Reindeer corral complex of drift logs set vertically and close together into the ground and the remains of a semi-subterranean house.	Historic (1930s)
HAR-018	NSB CRSI B	AHSOGEAK SITE	An area of fallen logs, scattered surface historic artifacts (e.g., stove, mirror, blue china).	Historic
HAR-019	TLUI 38 NSB CRSI 2238	ISUK (CAPE HALKETT)	Isook/Esook Trading Post - NSB TLUI #38 reports 9+ graves and 1+ ice cellars.	Historic
HAR-020	TLUI 44 NSB CRSI 2242	IKALUURUAK	A cabin, 2 graves, and 2 ice cellars.	Historic (AD 1927)
HAR-021	TLUI 45 NSB CRSI 2243	NIGLIVIK 1	Tent sites and ice cellars.	Historic
HAR-022	TLUI 49 NSB CRSI 2245	SAKITUI (SAKTUINA POINT)	Edwardsen's Trading Post - sod houses and 1+ graves. Most/all features have eroded away.	Historic
HAR-023	TLUI 42 NSB CRSI 2240	APALLIVIK	NSB TLUI #42 reports a tent campsite.	Historic
HAR-024	TLUI 50 NSB CRSI 2246	QIQIKTAG	NSB TLUI #50 reports "several small low islands…occasionally used as tent sites."	Historic
HAR-025	TLUI 51 NSB CRSI 2247	TIKIGAQMIUT (TIKIRAGMIUT, ESKIMO ISLANDS)	NSB TLUI #51 reports this as an "old cemetery of Point Hope people who were kept from going ashore by area residents" and eventually starved to death.	Historic
HAR-026	TLUI 52 NSB CRSI 2248	ATIGARU POINT (ATIGRUK POINT, AMAULIK)	NSB TLUI #52 reported graves, sod house ruins, tent sites, storage rack, recent wooden rack, caribou bone, skull and antler rack, rusted traps, fuel drums, and recent debris.	Historic
HAR-027	TLUI 53 NSB CRSI 2249	KANIGLUQ	NSB TLUI #53 reported sod house ruins and/or ice cellars.	Historic
HAR-028	TLUI 55 NSB CRSI 2250	NUKRUAPAITC H	Reported hunting and camping area.	Historic
HAR-029	TLUI 56 NSB CRSI 2251	IKKALIPIK	At least one sod house was reported here - site destroyed by erosion by 2000.	Historic
HAR-030	NSB CRSI 2276	HAR-030	A single sod house.	Historic
HAR-044			Recently tended grave.	Historic to modern
HAR-048		HAR-048	Sod house ruins (e.g., sod house remains, scattered surface debris [e.g., sheet metal wood stove, old lantern, tin cans, caribou rack]).	Historic (AD 1920-1930s)
HAR-049		HAR-049	A scatter of historic artifacts (e.g., tin lids, burned and fragmented caribou bone). The site is probably an activity area (possibly caribou processing) of HAR-048.	Historic (AD 1920-1930s)
HAR-051			Historic remains.	Historic
HAR-053		HAR-053	An isolated human skull that was released to the Native community for re-burial.	Historic
HAR-054		NECHELIK CHANNEL LIFEBOAT		Historic
HAR-058			U.S. Coast & Geodetic Survey bronze memorial	Historic
HAR-065			Small sod house foundation.	Historic
HAR-156	TLUI 60	NANUQ (NANUK, NANOOK)	Two sod house ruins occupied by 2 families of reindeer herders, 4 storage pits, 2 sod quarries, dog tethers, and scattered historic debris.	Historic (AD 1920s)
HAR-157	TLUI 45	NIGLIVIK 2	Sod house ruin, cache pit, sod quarry, and surface historic artifacts.	Historic

AHRS NO.	OTHER NO.[1]	SITE NAME	DESCRIPTION	DATE/PERIOD
HAR-158	TLUI 80	PUTU	Two sod house ruins, sod quarry, 2 fish curing pits, ice cellar, whale boat stern, and artifacts.	Historic
HAR-00159		NUIQSAPIAQ (FIRST NUIQSUT, NUIQSUTPIAT)	Five sod house ruins, ice cellar, sod quarries, and wooden stakes (tethers), tenting area, historic debris. Original village of Nuiqsut people, until flooding (1930s) forced move to Niglinaat (HAR-160).	Historic
TES-003		TES-003	Remains of a beached flat-bottomed, wood boat and hand axe (associated with the NARL cabin).	Historic
TES-006		TES-006	Camp site with artifacts (e.g., 2 carved tent pegs, worked wood object, sawn antler, hammerstone, tin can, pottery paddle, chopped/cut wood fragments, scattered caribou bone).	Historic
TES-011		TES-011	Isolated artifact-single-bladed kayak/boat paddle.	Historic
TES-013		TES-013	Isolated bear canine tooth (sawn/drilled), hematite/iron oxide, and caribou bones.	Historic
TES-016		TES-016	Isolated antler knife handle (2 small drilled holes and thin rectangular slot for metal blade).	Historic
TES-017		HORSE HEAD SITE	Two sod house ruins, a sod tent ring, 2 storage cellars, collapsed wood structure, mandible and skull of a Pleistocene horse, and historic debris.	Paleontological/ Historic
TES-018		TES-018	Historic remains (e.g., cracked/sawn caribou bone, 2 chert flakes, Euro-american items).	Historic (AD 1900s)
TES-019		TES-019	Tent ring structures marked by carved wooden stakes, sod blocks, and historic debris.	Historic (AD 1900s)
TES-021		TES-021	Five fire pits surrounded by sod windbreaks, sail cloth fragments, charred willow/alder, and bone.	Historic
TES-022			Umiak? remains.	Historic
TES-023			Caribou kill site.	Historic
TES-026		NW PIK DUNE SITE BLM SITES		Historic
TES-028		KOLOVIK	Trapping/trading location (e.g., standing houses, collapsed structures, 2 whaleboats, at least 4 surface burials).	Historic
TES-032			Lonely Long Range Radar Site (LRRS; POW-1) DEW-line facilities.	Historic
TES-033			Lonely LRRS (POW-1) DEW-line facilities.	Historic
TES-034			Lonely LRRS (POW-1) DEW-line facilities.	Historic
TES-035			Lonely LRRS (POW-1) DEW-line facilities.	Historic
TES-036			Lonely LRRS (POW-1) DEW-line facilities.	Historic
TES-037			Lonely LRRS (POW-1) DEW-line facilities.	Historic
TES-038			Lonely LRRS (POW-1) DEW-line facilities.	Historic
TES-039			Lonely LRRS (POW-1) DEW-line facilities.	Historic

AHRS NO.	OTHER NO.[1]	SITE NAME	DESCRIPTION	DATE/PERIOD
TES-040			Lonely LRRS (POW-1) DEW-line facilities.	Historic
TES-041			Lonely LRRS (POW-1) DEW-line facilities.	Historic
TES-042			Lonely LRRS (POW-1) DEW-line facilities.	Historic
TES-043**			Lonely Short Range Radar Site (SRRS) road system [White Alice Communications (WACS), Aircraft Control & Warning (AC&W)].	Historic
TES-044**			Lonely SRRS airfield [WACS, AC&W]	Historic
TES-045**			Lonely SRRS gravel pad system [WACS, AC&W].	Historic
TES-046			Sod houses.	Historic
TES-047		NW PIK DUNES SITE		Historic
TES-048**		POW-1 (LONELY) [DEW-LINE]	Auxiliary station of the DEW-line with train with rotating radar/support facilities, airstrip, pumphouse, warehouse, storage structures.	Historic (AD 1950s)
TES-049		IGSINAT (IGSINNAT)		Historic
TES-050		IGSUGVIK (IKSUGVIK)		Historic
TES-055		T78-2	Regal pail.	Historic
TES-056		T78-3	Caribou bones and shells.	Historic
UMI-007			Sod house.	Historic
UMI-091		KIK RIVER	Three 4' willow poles (ax sharpened), and rock ringed hearth.	Historic
UMI-103		UMIAT NPR-4 TEST WELL 2		Historic
UMI-104		UMIAT NPR-4 TEST WELL 5		Historic

[1] Multiple site numbers are provided in the AHRS database (e.g., TLUI, NSB CRSI, ROS).
* NHR (listed on the National Register of Historic Places).
** NRE (determined eligible for the National Register of Historic Places).
Source: Alaska Department of Natural Resources. 2004. *Alaska Heritage Resource Survey*. Division of Parks and Outdoor Recreation, Office of History and Archaeology.

Table I-2. Documented Traditional Land Use Inventory Sites

TLUI	TLUI (OLD)[1]	TLUI NAME	TRANSLATION	DESCRIPTION
TLUIHAR001		APALILVIK		FISHING/HUNTING AREA.
TLUIHAR002		APALILVIUM KUUWA	APALILVIK RIVER.	FISHING/HUNTING AREA.
TLUIHAR003		UQALIUM KAWIBAWA		FISHING/HUNTING AREA. OLD REINDEER HERDING CORRAL.
TLUIHAR004		TULUGAQ	TULUGAQ LAKE.	FISHING/HUNTING AREA.
TLUIHAR005		UQALIK	WITH A TONGUE.	FISHING/HUNTING AREA.
TLUIHAR006		INIBRUAT		OLD RUINS. HUNTING AREA.
TLUIHAR007		NARVABAURAQ	A SMALL LAKE.	FISHING/HUNTING AREA.
TLUIHAR008		TULUKKAM KUUWA	TULUGAQ RIVER.	FISHING/HUNTING AREA.
TLUIHAR009		SIKULIUM PAAWA	ENTRY/MOUTH OF THE SIKULIK RIVER.	FISHING/HUNTING AREA.
TLUIHAR010		SIKULIUM KUUWA	SIKULIK RIVER.	FISHING/HUNTING AREA.
TLUIHAR011		SIKULIUM IGLUA		CABIN. FISHING/HUNTING AREA.
TLUIHAR012		SIKULIUM NARVAWA	SIKULIK LAKE.	GRAVES/OLD RUINS. FISHING, CAMPING, HUNTING AREA.
TLUIHAR013	TLUI 48	NUYAPISUT		DRIFTWOOD AREA. TRAPPING/ HUNTING AREA.
TLUIHAR014		KIPUTIT		FISHING, TRAPPING, NESTING, HUNTING AREA.
TLUIHAR015		SAVIKPALIGAURAM IOITUBLIA		OLD SOD HOUSE RUINS. FISHING/ HUNTING AREA.
TLUIHAR016	TLUI 49	SAKTUI	SAKTUI ISLANDS.	SOD HOUSE RUINS/GRAVE SITE. A TRADING POST ONCE OWNED BY EDWARDSEN (NOT IN OPERATION). TRAPPING/HUNTING AREA (CARIBOU/SEALS).
TLUIHAR017		AYUVIOAM IEUVIA		GRAVESITE. HUNTING AREA.
TLUIHAR018		QAAQFIQ		FISHING, CARIBOU/GEESE HUNTING AREA.
TLUIHAR019		QUUNBUQ		FISHING/HUNTING AREA.
TLUIHAR020		KURRIUN		FISHING/HUNTING AREA.
TLUIHAR021		KUUGRUK	KUUGRUK RIVER.	FISHING/HUNTING AREA. EIDER NESTING AREA.
TLUIHAR022		KUUGRUK	KUUGRUK RIVER.	FISHING/HUNTING AREA. EIDER NESTING AREA.
TLUIHAR023		AYUVIOA	PLACE NAME DERIVED FROM A PERSON.	HUNTING AREA.
TLUIHAR024		QUUNBUQ		FISHING/HUNTING AREA.
TLUIHAR025		IKKALBUBRUAQ		TWO GRAVES, 2 CELLARS, CABIN (1927). FISHING/GEESE HUNTING AREA.
TLUIHAR026		IKKALBUBRUAM NARVAWA	IKKALGUGRUAQ LAKE.	FISHING/HUNTING AREA.
TLUIHAR027		QITIQ		HUNTING AREA.

TLUI	TLUI (OLD)[1]	TLUI NAME	TRANSLATION	DESCRIPTION
TLUIHAR028		ANNABUTCHIM KUUWA	ANNAGUTCHIQ RIVER.	FISHING/HUNTING AREA.
TLUIHAR029	TLUI 46	AKI (AGKI)		SOD HOUSE RUINS. HUNTING, CAMPING, TRAPPING AREA.
TLUIHAR030		NIBLIVIGAURAM KUUBUURAWA	NIGLIVIGAURAQ CREEK.	FISHING/HUNTING AREA.
TLUIHAR031		NIBLIVIGAURAM NARVAWI	NIGLIVIGAURAQ LAKES.	FISHING, TRAPPING, GEESE/ CARIBOU HUNTING AREA.
TLUIHAR032		ITIVLIQPAK	A BIG PLACE TO CROSS OVERLAND.	
TLUIHAR033		NIBLIVIGAURAM NARVAWA	NIGLIVIGAURAQ (A PLACE WHERE WHITE-FRONTED GEESE ARE FOUND) LAKE.	FISHING/HUNTING AREA.
TLUIHAR034	379	ISULIUMANIQ		FISHING/HUNTING AREA.
TLUIHAR035		TIWMIAQPALIK		FISHING, CARIBOU/GEESE HUNTING AREA.
TLUIHAR036		KUUGRUK		FISHING/HUNTING AREA. EIDER NESTING AREA.
TLUIHAR037		IQALUAQPALIK		FISHING, CARIBOU/GEESE HUNTING AREA.
TLUIHAR038		SAVIKPALIGAURAM IOITUBLIA		SOD HOUSE RUINS. FISHING/ HUNTING AREA.
TLUIHAR039		SIKULIUM KUUWA	SIKULIK RIVER.	FISHING/HUNTING AREA.
TLUIHAR040		AYUVIOA	PLACE NAME DERIVED FROM A PERSON.	HUNTING AREA.
TLUIHAR043		UBIABNAM IOITUBLIA		SOD HOUSE RUINS. FISHING, TRAPPING, HUNTING, CAMPING AREA.
TLUIHAR044		IKPITCHIAQ	A NEWLY FORMED HILL.	HUNTING AREA.
TLUIHAR045		NUNAM ISUA	THE END OF THE TUNDRA.	FISHING, TRAPPING, HUNTING AREA.
TLUIHAR047		PUBBIM PAAWA	MOUTH OF PUGGIQ BAY.	FISHING/HUNTING AREA.
TLUIHAR048		KAWITQUTCHAAM KUUWA	KANGITQUTCHAAK RIVER.	FISHING/HUNTING AREA.
TLUIHAR049		IKPITCHIAM PUBBIA	IKPITCHIAQ BAY.	FISHING/HUNTING AREA.
TLUIHAR051		UQSRUALUUM PAAWA	ENTRY/MOUTH OF THE UQSRUALUK RIVER.	FISHING, TRAPPING, HUNTING AREA.
TLUIHAR052		PUBBIQ	PUGGIQ LAKE.	FISHING/HUNTING AREA.
TLUIHAR053		IMAQPAK	A LITTLE LARGER THAN A SMALL BODY OF WATER.	FISHING/HUNTING AREA.
TLUIHAR054		IMAQPAURAQ	SMALL WATER.	FISHING/HUNTING AREA.
TLUIHAR055		UQSRUALUUM KUUWA	UQSRUALUK RIVER.	FISHING, TRAPPING, AND HUNTING AREA.
TLUIHAR057		QAUGAGUIQSAABVIK	LAST PLACE HUNTERS CAN BE ASSURED OF GETTING DUCKS.	A CEMETERY IS LOCATED AT THIS SITE.
TLUIHAR058		UQSRUALUUM NARVAWA	UQSRUALUK LAKE.	FISHING, TRAPPING, HUNTING AREA.
TLUIHAR059				NO DATA
TLUIHAR060				NO DATA
TLUIHAR061				NO DATA
TLUIHAR062				NO DATA

TLUI	TLUI (OLD)[1]	TLUI NAME	TRANSLATION	DESCRIPTION
TLUIHAR063				NO DATA
TLUIHAR064				NO DATA
TLUIHAR067				NO DATA
TLUIHAR068				NO DATA
TLUIHAR075				NO DATA
TLUIHAR077				NO DATA
TLUIHAR080				NO DATA
TLUIHAR086				NO DATA
TLUIHAR087				NO DATA
TLUIHAR088				NO DATA
TLUIHAR089				NO DATA
TLUIHAR090				NO DATA
TLUIHAR091				NO DATA
	TLUI 1	UGIIN		CABINS, SOD HOUSE RUINS, WINTER FURBEARER HUNTING.
	TLUI 4	NIGLIGIAQ		FISHING, FURBEARER/CARIBOU HUNTING AREA.
	TLUI 8	IGLUPARAK		FISHING AREA.
	TLUI 43	SIKULIK		CABINS, SOD HOUSE RUINS, GRAVES. FISHING AREA.
	TLUI 44	IKALUURUAK		CABIN, ICE CELLARS, GRAVES, FISHING, WINTER CARIBOU HUNTING AREA.
	TLUI 53	KANGIGKUQ (KANGIGLUQ)		SOD HOUSE RUINS, OLD FISH CAMP. FISHING/TRAPPING AREA.
	TLUI 54	NIAQUQTURUQ		SOD HOUSE RUINS. FISHING, DUCK HUNTING, BIRD NESTING AREA.
	TLUI 55	NIKRUAPAITCH		HUNTING, CAMPING, BIRD NESTING AREA.
	TLUI 61	NUIQSUT		GRAVES (CEMETERY). FISHING, TRAPPING, HUNTING, CAMPING AREA. CURRENT SITE FOR THE COMMUNITY OF NUIQSUT.
	TLUI 72	ILLANIKRUAK, ILANNIK		FISHING/TRAPPING AREA.
	TLUI 78	KAYAKTUAGIAK		FISHING, HUNTING, CAMPING AREA.
	TLUI 81	ITTIGIAK, OCEAN POINT		HUNTING/BERRY HARVESTING.
TLUIIKR019		IKPIKPAUM KUUWA	IKPIKPAK (FOOTHILLS) RIVER.	FISHING, TRAPPING, HUNTING AREA.
TLUIIKR021		QUBLUQTUM PAAWA	ENTRY/MOUTH OF THE QUGLUKTUQ RIVER.	FOSSIL MATERIAL. LANDMARK FOR PEOPLE TRAVELING FROM SMITH BAY TO HUNT CARIBOU.
TLUIIKR022		QUBLUQTUM KUUWA	QUGLUQTUQ RIVER.	A STOPOVER PLACE. CARIBOU HUNTING AREA.

TLUI	TLUI (OLD)[1]	TLUI NAME	TRANSLATION	DESCRIPTION
TLUIIKR023		IKPIKPAUM KUUWA	IKPIKPAK (FOOTHILLS) RIVER.	FISHING, TRAPPING, HUNTING AREA.
TLUIIKR024		SANNIWARUAQ	A RIVER FLOWING SIDEWAYS	MAJOR CARIBOU HUNTING AREA. PEOPLE CROSSED HERE TO BEGIN TRAVELING TO THE COLVILLE TO HUNT CARIBOU.
TLUIIKR026		IKPIKPAUM KUUWA	IKPIKPAK (FOOTHILLS) RIVER.	FISHING, TRAPPING, HUNTING AREA.
TLUIIKR038		QIRUIEAQ, BRONX CREEK	QIRUILAQ (PLACE WITHOUT WOOD) RIVER.	FISHING, TRAPPING, HUNTING AREA.
TLUIIKR051				NO DATA
TLUITES043		IMABRUAM AWMALUAQTUAQ	IMAGRUAQ LAKE.	THIS LAKE HAS DRIED UP AND IS A MUDDY SWAMP. HUNTING AREA.
TLUITES044		QIMIBABRUAQ	NAME GIVEN TO THE HIGH RIDGES.	HUNTING/TRAPPING AREA.
TLUITES045		TUQDUK		FISHING/HUNTING AREA.
TLUITES047		NANUBAQTALIK		FISHING, HUNTING, NESTING AREA.
TLUITES048		MAYUBIAM KUUWA, MIGUAKIAK RIVER	MAYUGIAQ (TO CLIMB OR CLIMB UP) RIVER.	PART OF AN INLAND ROUTE TO THE EAST.
TLUITES049		PIQQIM QIMIBAWIOOI	PIQQIQ HILLS.	HUNTING/NESTING AREA.
TLUITES050		NIBLIBAAM PAAWA	ENTRY/MOUTH OF NIGLIGAAQ (GOOSE) CREEK.	SUMMER FISHING, HUNTING, GOOSE NESTING AREA.
TLUITES051		NIBLIBAAM KUUBUURAWA	NIGLIGAAQ (GOOSE) CREEK.	SUMMER FISHING, HUNTING, GOOSE NESTING AREA.
TLUITES052		SUQDAK, SUQDAIT		SOD HOUSE RUINS, ICE CELLARS. FISHING, TRAPPING, CARIBOU HUNTING AREA, NESTING AREA.
TLUITES054		KIMMITQUM KAWIQFUA	KIMMITQUQ BEND.	FISHING, TRAPPING, HUNTING AREA.
TLUITES055		AKDABAALUK	WHERE BROWN BEARS ROAM.	CABINS. FISHING, CARIBOU HUNTING, GEESE NESTING AREA.
TLUITES056		PIQQIM NARVAWA	PIQQIQ LAKE.	FISHING/HUNTING AREA.
TLUITES057		PIWUTUUM PAAWA	ENTRY/MOUTH OF THE PINGUTUUQ (PINGOS FOUND ALONG THE RIVER BANK) RIVER.	HUNTING/FISHING AREA.
TLUITES058		PIQQIQ		HUNTING AREA.
TLUITES059		PIWUTUUM KUUWA	PINGUTUUQ (PINGOS FOUND ALONG THE RIVER BANK) RIVER.	HUNTING/FISHING AREA.
TLUITES060		QAUQTUM PAAWA	ENTRY/MOUTH OF QAUQTUQ LAKE.	FISHING, FOX TRAPPING, CARIBOU HUNTING AREA.

TLUI	TLUI (OLD)[1]	TLUI NAME	TRANSLATION	DESCRIPTION
TLUITES061		IKSUBVIUM QIKIQTAWA	IKSUGVIK ISLAND.	FISHING, TRAPPING, HUNTING AREA.
TLUITES062		QAUQTUM NARVAWA	QAUQTUQ LAKE.	FISHING, FOX TRAPPING, CARIBOU HUNTING AREA.
TLUITES063		MASRIIN		FISHING/HUNTING AREA.
TLUITES064		IKSUBVIK	IKSUGVIK	MARKS SHOWING WHERE/HOW FAR COMPETITORS JUMPED DURING INUPIAT GAMES. FISHING, TRAPPING, HUNTING AREA.
TLUITES065		IKSUBVIUM KUUWA	IKSUGVIK RIVER.	FISHING, TRAPPING, HUNTING AREA.
TLUITES066		TUPQUTAAM KUUWA	TUPQUTAAQ RIVER.	FISHING, TRAPPING HUNTING AREA.
TLUITES067		KUYAPIGAM NUVUA	KUYAPIGAQ POINT.	FISHING, TRAPPING HUNTING AREA.
TLUITES068		KUYAPIGAQ		FISHING, TRAPPING, HUNTING AREA.
TLUITES069		QIKIQTAQ	AN ISLAND.	HUNTING, FISHING, TRAPPING AREA.
TLUITES070		KIGEAVAIT NUVUA	KIGLAVAIT POINT.	HUNTING AREA.
TLUITES071		KIGEAVAIT IOITUBLIA		RUINS. HUNTING, CAMPING AREA.
TLUITES072		KIGEAVAIT KUUWA	KIGLAVAIT RIVER.	FISHING/HUNTING AREA.
TLUITES073		PIWUBRUK	PINGUGRUK RIVER.	FISHING/HUNTING AREA.
TLUITES074		KUUPADDUK	A BAD RIVER.	LONG AGO, INUPIAT PEOPLE CAMPED AT THIS SITE AND WERE ATTACKED BY INDIANS.
TLUITES075		IKPIKPAGRUAM KUUWA KIVALLIQ	EAST IKPIKPAGRUAQ (LARGE FOOTHILLS) RIVER.	FISHING, TRAPPING, HUNTING ALONG THE RIVER.
TLUITES077		IKPIKPAGRUAM KUUWA KIVALLIQ	EAST IKPIKPAGRUAQ (LARGE FOOTHILLS) RIVER.	FISHING, TRAPPING, HUNTING ALONG THE RIVER.
TLUITES078		PIWUGRUUM PAAWA	ENTRY/MOUTH OF THE PINGUGRUK (HIGH MOUND/HILL) RIVER.	FISHING, TRAPPING, CARIBOU HUNTING AREA.
TLUITES079		PITTABRUAQ	PITTAGRUAQ LAKE.	CARIBOU PASS THROUGH THIS LAKE DURING THEIR ANNUAL MIGRATION.
TLUITES080		PIWUBRUUM KUUWA	PINGUGRUK (HIGH MOUND/HILL) RIVER.	FISHING, TRAPPING, CARIBOU HUNTING AREA.
TLUITES082		SIBVAN		DOME (100+ FT ABOVE SEA LEVEL). IMPORTANT LANDMARK FORMS PART OF THE RIDGE SYSTEM (QUAGRUGAGRUAQ).
TLUITES083		TABBAQ	A SHADOW OR REFLECTION (E.G., A MIRROR).	ROUND BLUFF WITH OPENING ON ONE END - NATURAL CORRAL USED BY REINDEER HERDERS.
TLUITES084		IKPIKPAGRUAM KAYYAAK	TES	MAJOR HUNTING, FISHNG, TRAPPING AREA.

TLUI	TLUI (OLD)[1]	TLUI NAME	TRANSLATION	DESCRIPTION
TLUITES085		IEAVGAWALUK	PLACE NAME DERIVED FROM A PERSON.	OLD RUINS (E.G., CELLAR, SOD HOUSE). FISHING AREA.
TLUITES086		TAQTU	PLACE NAME DERIVED FROM A PERSON.	DOME (160+ FT ABOVE SEA LEVEL). IMPORTANT LANDMARK.
TLUITES087		KIGALASAK		HUNTING/CAMPING AREA.
TLUITES088		ISULIUMANIQ		CARIBOU CROSSING AREA
TLUITES089		AQSIIO	PLACE NAME DERIVED FROM A PERSON.	DOME (150+ FT ABOVE SEA LEVEL).
TLUITES090		NUISATCHIQ	NUISATCHIQ HILL.	MOSQUITOES DURING THE SUMMER - CARIBOU MIGRATION ROUTE. HUNTING AREA.
TLUITES091		ASUAQ		HISTORIC CAMP SITE. FISHING, HUNTING, CAMPING, BLUEBERRY HARVEST AREA.
TLUITES092		QIUKKAM IMAWA	PLACE NAME DERIVED FROM A PERSON.	HUNTING AREA.
TLUITES094		UBVIK	A PLACE TO TURN A BOAT UPSIDE DOWN AND LEAN IT AGAINST SOMETHING.	LANDMARK (FOUR CORNERS OF A HILL). HISTORIC REMAINS. FISHING AREA (BROAD WHITEFISH AND GRAYLING). TRAPPING AREA.
TLUITES095		IBIOBAATKUT IOITUBLIA		OLD RUINS. FISHING, TRAPPING, CARIBOU/GEESE HUNTING AREA.
TLUITES096		AYABAAT, AYAQHAAT	AYAGAAT AND AYAQHAAT LAKES.	FISHING, CARIBOU/GEESE HUNTING AREA.
TLUITES097		AKIQPAK		CAMPING SITE, POSSIBLE BURIAL SITE. PEOPLE WINTERED HERE IN THE PAST. FISHING, TRAPPING, HUNTING AREA.
TLUITES099		ULUABRUUM NATIBNAWA	ULUAGRUK FLATLAND.	HUNTING AREA. GOOSE FEEDING GROUNDS.
TLUITES100		QIATUNA	QIATUNA LAKE.	FISHING/HUNTING AREA.
TLUITES101		ITVLIURAQ	A SMALL CROSSING AREA.	FISHING/HUNTING AREA.
TLUITES102		ULUABRUK		CABIN (NSB DWM). FISHING, TRAPPING, CARIBOU/GOOSE HUNTING AREA.
TLUITES103		QAVIARAT	FINE SAND.	OLD NARL CABIN. GOOSE HUNTING AREA. FISHING, TRAPPING, HUNTING AREA.
TLUITES104		ABNAQSAQ	AGNAQSAQ LAKE.	FISHING/HUNTING AREA.
TLUITES105		KUVRABLIQ	A PLACE TO PUT OUT A FISH NET.	FISHING/HUNTING AREA.
TLUITES106		QAVIARAT NUVUA	QAVIARAT (FINE SAND)	FISHING, TRAPPING,

TLUI	TLUI (OLD)[1]	TLUI NAME	TRANSLATION	DESCRIPTION
			HILL.	HUNTING AREA.
TLUITES107		KIMMITQUM KUUBUURAWA	KIMMITQUQ CREEK.	FISHING, TRAPPING, HUNTING AREA.
TLUITES108		QAVIARAT	FINE SAND.	FISHING/HUNTING AREA.
TLUITES109		AMIEBUBRUAM NUVUA	AMILGUGRUAQ POINT.	HUNTING AREA.
TLUITES110		SIWIGRUAQ	SINGIGRUAQ POINT.	FISHING/HUNTING AREA.
TLUITES111		AMIEBUBRUAQ		HUNTING AREA.
TLUITES112		KUUGAALBIT		FISHING/HUNTING AREA.
TLUITES113		ISUA	THE END OF SOMETHING.	HUNTING AREA.
TLUITES114		SIWIBRUAM AKIEEIA, MAURVIUM NUVUA, TAGLIM NUVUA	MAURVIK AND TAGLI POINT. SECOND SINGIGRUAQ POINT.	FISHING, GEESE/CARIBOU HUNTING AREA.
TLUITES115		TAGLIM PAAWA	ENTRY/MOUTH OF THE TAGLI RIVER.	FISHING (BROAD WHITEFISH, LEAST CISCO, LAKE TROUT/CHAR), GEESE/CARIBOU HUNTING AREA.
TLUITES116		QIMMIT NALLUATA PAAWA	QIMMIT NALLUAT RIVER ENTRY/MOUTH.	FISHING/HUNTING AREA.
TLUITES117		TAGLI		FISHING (BROAD WHITEFISH, LEAST CISCO, LAKE TROUT/CHAR), CARIBOU/GEESE HUNTING AREA. FISHING TRAIL.
TLUITES118		QIMMIT NALLUATA KUUWA	QIMMIT NALLUAT RIVER.	FISHING, TRAPPING/HUNTING AREA.
TLUITES119		NIEEUVIK		FISHING/HUNTING AREA.
TLUITES120		SAQDAK	TO HOLLER OR YELL.	FISHING/HUNTING AREA.
TLUITES121		ALABIM NUVUA UALLIQ	WEST ALAGI POINT.	HUNTING AREA.
TLUITES122		ALABIMLU UYABALIUMLU NUVUA	ALAGI AND UYAGALIK POINT.	HUNTING AREA.
TLUITES123		NIAQUQTUABRUUM		HUNTING AREA.
TLUITES124		QAYAUVIUM KUUWA	QAYAUVIK RIVER.	FISHING/HUNTING AREA.
TLUITES125		UYABALIGUM NUVUA	UYAGALIK POINT.	FISHING/HUNTING AREA.
TLUITES126		ALABIM KAWIQFUA	ALAGI BEND.	FISHING/HUNTING AREA.
TLUITES127		UYABALIGUM IEULIAWA	UYAGALIK BAY.	FISHING/HUNTING AREA.
TLUITES128		QAYAUVIK	PLACE TO GO BOATING WITH A QAYAQ.	FISHING/CARIBOU HUNTING AREA.
TLUITES129		MAURVIUM KUUWA	MAURVIK RIVER.	FISHING, TRAPPING, HUNTING AREA.
TLUITES130		MAURVIUM IEULIAWA	MAURVIK BAY.	FISHING/HUNTING AREA.
TLUITES131		MAURVIUM IGLUBRAUWI		RUINS. FISHING, TRAPPING, CAMPING, HUNTING AREA.
TLUITES132		TAGLI		FISHING (BROAD WHITEFISH, LEAST CISCO, LAKE TROUT), CARIBOU/GEESE HUNTING AREA. FISHING TRAIL.

TLUI	TLUI (OLD)[1]	TLUI NAME	TRANSLATION	DESCRIPTION
TLUITES133		UYABALIK		CABIN, SOD HOUSE RUINS, ICE CELLAR. FISHING, TRAPPING, HUNTING AREA.
TLUITES134		UYABALIGUM KUUWA	UYAGALIK RIVER.	FISHING/HUNTING AREA.
TLUITES135		ALABI		OLD RUIN. SHAMAN STORY. FISHING/HUNTING AREA.
TLUITES136		KAYYAAK	SPLIT BETWEEN RIVERS.	FISHING, TRAPPING, HUNTING AREA.
TLUITES137		KAMA		OLD GRAVE. FISHING/HUNTING AREA.
TLUITES138		UYABALIGUM NARVAWA	UYAGALIK LAKE.	FISHING AREA.
TLUITES139		KAMAM NARVAWA	KAMA LAKE.	FISHING/HUNTING AREA.
TLUITES140		TAGLIM SAQUUBUUTAA	A BEND IN THE TAGLI RIVER.	FISHING, TRAPPING, HUNTING AREA.
TLUITES141		TAGLIM SAQUUBUUTAA	A BEND IN THE TAGLI RIVER.	FISHING, TRAPPING, HUNTING AREA.
TLUITES142		TAGLI		FISHING (BROAD WHITEFISH, LEAST CISCO, LAKE TROUT), CARIBOU/GEESE HUNTING AREA. FISHING TRAIL.
TLUITES143		NALLUBRUAQ	NALLUGRUAQ SAND DUNES.	CARIBOU/GEESE HUNTING AREA.
TLUITES144		ANABI	ANAGI LAKE.	FISHING AREA.
TLUITES145		TAGLI		FISHING (BROAD WHITEFISH, LEAST CISCO, LAKE TROUT/CHAR), CARIBOU/GEESE HUNTING AREA. FISHING TRAIL.
TLUITES146		NALLUBRUAQ	NALLUGRUAQ SAND DUNES.	CARIBOU/GEESE HUNTING AREA.
TLUITES147		SIGGUYUGRUAQ	SIGGUYUGRUAQ LAKE.	FISHING, CARIBOU/GEESE HUNTING AREA.
TLUITES148		TAKKAUM IOITUBLIA	PLACE NAME DERIVED FROM A PERSON.	SOD HOUSE RUINS. REINDEER CORRAL. FISHING, CARIBOU, GEESE HUNTING AREA.
TLUITES149		QIWAQTAM IOITUBLIA	PLACE NAME DERIVED FROM A PERSON.	SOD HOUSE RUINS. FISHING, CARIBOU/GEESE HUNTING AREA.
TLUITES150		UVLUTUUQ	UVLUTUUQ RIVER.	FISHING, CARIBOU, GEESE HUNTING AREA.
TLUITES151		UVLUTUUQ	UVLUTUUQ RIVER.	FISHING, CARIBOU AND GEESE HUNTING AREA.
TLUITES152		INIKAAK	INIKAAK RIVER.	PILE OF ANTLERS. FISHING, TRAPPING, CARIBOU/GEESE HUNTING AREA.
TLUITES202		IMABRUAM IKPIGRUAWA	IMAGRUAQ HILL.	HUNTING AREA.
TLUITES205		IMABRUAM PAAWA	ENTRY/MOUTH OF THE IMAGRUAQ RIVER.	THIS RIVER HAS DRIED UP. OLD HUNTING/FISHING AREA.
TLUITES207		NUNAM ISUA		HUNTING AREA.
TLUITES208		IPIIQSAUN		FISHING, HUNTING, NESTING AREA.

TLUI	TLUI (OLD)[1]	TLUI NAME	TRANSLATION	DESCRIPTION
TLUITES211		IMABRUAM KUUWA	IMAGRUAQ RIVER.	THS RIVER HAS DRIED UP. HUNTING AREA.
TLUITES212		AMIEBUGIIK		FISHING/HUNTING AREA.
TLUITES215		NALLUQ		HUNTING AREA.
TLUITES216		AYAGUTAQ		HUNTING AREA.
TLUITES217		NALLUABRUUM PAAWA	ENTRY/MOUTH OF THE NALLUAGRUK RIVER.	FISHING/HUNTING AREA.
TLUITES218		SISAMALIK		HUNTING AREA.
TLUITES219		KUUGRUAGAABRUK		FISHING/HUNTING AREA.
TLUITES220		TASIABRUK		FISHING/HUNTING AREA.
TLUITES222		QALLUVIK		STANDING/COLLAPSED HOUSES, 2 WHALE BOATS. LARGE POPULATION (1930s).
TLUITES223		QIMIGAYUK	NAME REFERS TO THE FOOTHILLS.	FISHING/HUNTING AREA.
TLUITES225		NATIBNAURAQ	SMALL FLAT LAND.	HUNTING AREA.
TLUITES226		KIWIOWUQ		HUNTING AREA.
TLUITES227		QIRUKTABIAQ	A PLACE TO GO COLLECT DRIFTWOOD FOR SHELTER/FUEL.	HUNTING AREA.
TLUITES229		IGLUQABVIALUK		OLD HOUSES. FISHING/HUNTING AREA.
TLUITES230		TIGUTAAM PAAWA	ENTRY/MOUTH OF THE TIGUTAAQ RIVER.	FISHING/HUNTING AREA.
TLUITES232		QAGGAQ	QAGGAQ LAKE.	FISHING/HUNTING AREA.
TLUITES233		KUVRABLIQ	PLACE TO PUT OUT NET.	FISHING/HUNTING AREA.
TLUITES235		NALUABRUUM KUUWA	NALLUAGRUK RIVER.	FISHING/HUNTING AREA.
TLUITES236		MITITUAM KUUBUURAWA	MITITUAQ CREEK.	FISHING/HUNTING AREA.
TLUITES237		KIOAVIAQ	PLACE NAME DERIVED FROM A PERSON.	OLD HUNTING/CAMPING AREA.
TLUITES238		TIGUTAAM KUUWA	TIGUTAAQ RIVER.	FISHING/HUNTING AREA.
TLUITES239		NALLUABRUK AWMALUAQTUAQ	NALLUAGRUK LAKE.	LAKE HAS DRIED UP AND IS A MUDDY SWAMP. HUNTING AREA.
TLUITES240		NALLUABRUK	NALLUAGRUK LAKE.	FISHING/HUNTING AREA.
TLUITES241		AKUVAAM IOITUBLIA	PLACE NAME DERIVED FROM A PERSON.	SOD HOUSE RUINS. FISHING, HUNTING AREA.
TLUITES242		UQALIK	WITH A TONGUE.	FISHING/HUNTING AREA.
TLUITES243		YUGAARIQ	PLACE NAME DERIVED FROM A PERSON.	GRAVE SITE. HUNTING AREA.
TLUITES244		TIGUTAAQ	TIGUTAAQ LAKE.	FISHING/HUNTING AREA.
TLUITES245		IMABRUAQ	BIG WATER.	OLD SOD HOUSES (ERODED), GRAVE.
TLUITES246		IGLIBAQ	IGLIGAQ LAKE.	FISHING, TRAPPING, HUNTING AREA.
TLUITES247		NARVAQ	LAKE.	FISHING/HUNTING AREA.
TLUITES249				NO DATA
TLUITES250				NO DATA
TLUITES251				NO DATA
TLUITES252				NO DATA

TLUI	TLUI (OLD)[1]	TLUI NAME	TRANSLATION	DESCRIPTION
TLUITES253				NO DATA
TLUITES254				NO DATA
TLUIUMI002				NO DATA
TLUIUMI005				NO DATA
TLUIUMI008				NO DATA

[1] Many TLUI sites have identifying numbers from two different number systems: one used in the 1970s (TLUI [old]) (Hoffman et al. 1988) and one developed later (North Slope Borough 2003).

Sources: Hoffman, D., D. Libbey, and G. Spearman. 1988. *Nuiqsut: Land Use Values Over Time in the Nuiqsut Area*. North Slope Borough and the Anthropology and Historic Preservation Section of the Cooperative Park Studies Unit Occasional Paper No. 12. University of Alaska, Fairbanks, Alaska; NSB. 2003. Unpublished Subsistence Survey Data. North Slope Borough, Division of Wildlife Management, Barrow, Alaska.

Appendix J: BLM Sensitive Species List for Alaska

Appendix J

BLM Sensitive Species List For Alaska

Appendix J

BLM Sensitive Species List for Alaska

Common Name	Scientific Name
PLANTS	
Alaska bluegrass	*Poa hartzii alaskana*
Alaskan glacier buttercup	*Beckwithia glacialis* spp. *alaskansis*
Aleutian saxifrage	*Saxifraga aleutica*
Aleutian whitlow-grass	*Draba aleutica*
Aleutian wormwood	*Artemisia aleutica*
Alpine draba	*Draba micropetala*
Arctic locoweed	*Oxytropis arctica* var. *barnedyana*
Bering dwarf primrose	*Douglasia beringensis*
Calder's bladderpod	*Lesquerella calderi*
Calder's licorice-root	*Ligusticum calderi*
Drummond's bluebell	*Mertensia drummondii*
Hairy lousewort	*Pedicularis hirsuta*
Kobuk locoweed	*Oxytropis kobukensis*
Moonwort	*Botrychium ascendens*
Mountain avens	*Senecio moresbiensis*
Muir's fleabane	*Erigeron muirii*
Murray's whitlow-grass	*Draba murrayi*
Narrow-leaved prairie rocket	*Erysimum asperum* var. *angustatum*
Nodding semaphoregrass	*Pleuropogon sabinei*
Ogilvie Mountains springbeauty	*Claytonia ogilviensis*
Ogilvie Mountains whitlow-grass	*Draba ogilviensis*
Pear-shaped candytuft	*Smelowskia pyriformis*
Purple wormwood	*Artemisia globularia* var. *lutea*
Pygmy aster	*Aster pygmaeus*
Sessile-leaved scurvy grass	*Cochlearia sessilifolia*
Shacklette's catseye	*Cryptantha shacletteana*
Stipulated cinquefoil	*Potentilla stipularis*
Tundra whitlow-grass	*Draba kananaskis*
Willow	*Salix reticulata* spp. *glabellicarpa*
Yellow-ball wormwood	*Artemisia senjavinensis*
Yukon podistera	*Podistera yukonensis*
Yukon wild buckwheat	*Eriogonum flavum* var. *aquilinum*

Common Name	Scientific Name
FISH	
Angayukaksurak char	*Salvelinus anaktuvukensis*
Beaver Creek chinook salmon	*Oncorhynchus tshawytscha*
Clear Creek chum salmon	*Oncorhynchus keta*
Gulkana steelhead	*Oncorhynchus mykiss*
Kigliak char	*Salvelinus alpinus*
Western brook lamprey	*Lampetra richardsoni*
BIRDS	
Black brant	*Branta bernicla*
Black guillemot	*Cepphus grylle*
Black scoter	*Melanitta nigra*
Blackpoll warbler	*Dendroica striata*
Black-tailed godwit	*Limosa limosa*
Bristle-thighed curlew	*Numenius tahitiensis*
Buff-breasted sandpiper	*Tryngites subruficollis*
Dovekie	*Alle alle*
Dusky Canada goose	*Branta canadensis occidentalis*
Gray-cheeked thrush	*Catharus minimus*
Harlequin duck	*Histrionicus histrionicus*
King eider	*Somateria spectabilis*
Kittlitz's murrelet	*Brachyramphus brevirostris*
Long-tailed duck	*Clangula hyemalis*
Marbled godwit	*Limosa fedoa*
Marbled murrelet	*Brachyramphus marmoratus*
McKay's bunting	*Plectrophenax hyperboreus*
Northern goshawk (Queen Charlotte)	*Accipiter gentilis laingi*
Olive-sided flycatcher	*Contopus cooperi borealis*
Red knot	*Calidris canutus*
Red-throated loon	*Gavia stellata*
Surf scoter	*Melanitta perspicillata*
Townsend's warbler	*Dendroica townsendi*
Trumpeter swan	*Cygnus buccinator*
Tule white-fronted goose	*Anser albifrons gambelli*
Yellow-billed loon	*Gavia adamsii*
MAMMALS	
Canada lynx	*Lynx canadensis*
Harbor seal	*Phoca vitulina concolor*

Appendix K: Information, Models, and the Assumptions Used to Analyze the Effects of Oil Spills

Appendix K

Information, Models, and the Assumptions Used to Analyze the Effects of Oil Spills

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APPENDIX K

INFORMATION, MODELS, AND ASSUMPTIONS USED TO ANALYZE THE EFFECTS OF OIL SPILLS

This Supplement to the Amended IAP/EIS analyzes oil spills, and their potential impacts to environmental, economic, and sociocultural resources and resource areas, which could result from onshore oil exploration and development in the Northeast National Petroleum Reserve – Alaska (NPR-A). Predicting an oil spill is an exercise in probability. There is uncertainty associated with the location, number, and size of oil spills, the chemistry of the oil, and the environmental conditions at the time of a spill. Although some of the uncertainty reflects incomplete or imperfect data, there is also a considerable amount of uncertainty involved in predicting events 15 to 25 years into the future. However, the chance of an oil spill occurring can be estimated using historical data.

Assumptions about oil spills are used to analyze the effects of oil spills. These assumptions pertain to the type of oil, the source of an oil spill, the general location and size of a spill, the chemistry of the oil, how the oil will weather, how long the oil will remain, and where the oil will go. Project-specific information, statistical analysis, and professional judgment support the assumptions. Based on these assumptions, a scenario is created to reflect a spill, and the effects of such a spill are analyzed. These steps constitute a "what if a spill occurs" analysis.

This oil spill analysis considers the entire production life of the planning area, and assumes that commercial quantities of hydrocarbons are present in the planning area and that these hydrocarbons will be developed and produced at the estimated resource levels presented in the Supplemental IAP/EIS. Uncertainties exist, such as 1) the actual resource levels, 2) the actual size of a crude or refined oil spill, 3) the approximate location of oil assumed to be produced, and 4) whether production would occur at all. If no hydrocarbons exist, there is no chance of a crude oil spill occurring in the planning area.

K.1 Oil Spill Size Categories

This Supplement analyzes what is likely to happen in the future, using assumptions about the likely size, duration, and type of a spill to analyze the effects. To estimate these parameters, oil spills are divided into two types: crude oil and refined oil spills. Crude oil spills are divided into three size categories: small, large, and very large. Within each of these categories, generalized and specific assumptions are made. Refined spills fall into the small spill size category.

Small spills are defined as those less than 500 barrels (bbl; 1 bbl = 42 gallons); large spills are greater than or equal to 500 bbl or 1,000 bbl (depending upon the data source); and very large spills are greater than or equal to 120,000 bbl. Table K-1 shows the assumed source of a spill(s), type of oil, size of spill(s) in bbl, and the receiving environment that is assumed in the analysis of the effects of oil spills in this Supplement. The effects of spill(s) are analyzed in Chapter 4 (Environmental Consequences). The following sections discuss the oil spill analysis, and the assumptions used for analysis, for each of these three size categories.

K.1.1 Probability of a Large Crude Oil Spill

Large spills are defined as greater than or equal to 500 bbl for the Alaska North Slope and Trans-Alaska Pipeline System (TAPS), and greater than or equal to 1,000 bbl for the TAPS tankers. Historical information about previous large spills on the Alaska North Slope, from TAPS, and from TAPS tankers was used to estimate the hypothetical size of large spills and the rate at which such large spills would be expected to occur in the future.

Table K-1. Oil Spill Scenario Assumptions for the Alternatives

<table>
<tr><th rowspan="2">Source of Spill</th><th rowspan="2">Type of Oil</th><th rowspan="2">Size of Spill (bbl)</th><th colspan="4">Assumed Number of Spills Under Each Alternative</th><th rowspan="2">Receiving Environment</th></tr>
<tr><th>A</th><th>B</th><th>C</th><th>D</th></tr>
<tr><td colspan="8">Small Spills (< 500 bbl) Onshore and Offshore</td></tr>
<tr><td rowspan="2">Operational spills from all sources</td><td>Crude</td><td>3</td><td>561</td><td>596</td><td>721</td><td>659</td><td rowspan="2">Ice, tundra, snow, gravel pad, and water</td></tr>
<tr><td>Refined</td><td>0.7</td><td>1,276</td><td>1,474</td><td>1,782</td><td>1,628</td></tr>
<tr><td colspan="8">Large Spills (≥ 500 bbl) Onshore or Offshore</td></tr>
<tr><td>Pipeline</td><td>Crude</td><td>4,800</td><td rowspan="3">2</td><td rowspan="3">3</td><td rowspan="3">3</td><td rowspan="3">3</td><td rowspan="3">Ice, tundra, snow, gravel pad, and water</td></tr>
<tr><td>Platform/gravel pad</td><td>Crude</td><td>900</td></tr>
<tr><td>Storage tank/gravel pad</td><td>Diesel</td><td>900</td></tr>
<tr><td colspan="8">Very Large Spills (≥ 120,000 bbl)</td></tr>
<tr><td>Well blowout</td><td>Crude</td><td>120,000</td><td>Not Applicable</td><td>Not Applicable</td><td>Not Applicable</td><td>Not Applicable</td><td>Ice, tundra, snow, gravel pad, and water</td></tr>
</table>

K.1.1.1 Historical Large Crude Oil Spill Sizes

Assumptions for large spills from production in the planning area are based on the historic spill sizes from onshore Alaska North Slope oil industry spills from 1985 to 2000, TAPS spills from 1977 to 2001, and TAPS tanker spills from 1977 to 1999. Additional consideration is given to the large spill that occurred in March 2006 known as the GC-2 Oil Transit Line Release.

Historical Crude Oil Spills Greater Than or Equal to 500 Barrels on the North Slope

The Alaska North Slope oil spill analysis includes onshore oil and gas exploration and development spills from the Point Thompson Unit, Badami Unit, Kuparuk River Unit, Milne Point Unit, Prudhoe Bay West Operating Area, Prudhoe Bay East Operating Area, and offshore Duck Island Unit (Endicott). Alaska North Slope data include spills from onshore pipelines and offshore and onshore production and gathering facilities. The following information does not include spills on the Alaska North Slope from the TAPS, which were evaluated separately.

For the Alaska North Slope, all available information on historic spills greater than or equal to 100 bbl during the period 1968 through 2000 was obtained from industry and regulatory agencies and collated (Anderson and LaBelle 2000, Hart Crowser, Inc. 2000). Information on the 2006 GC-2 Oil Transit Line Release came from Situation Reports posted on the Alaska Department of Environmental Conservation website. The USDOI MMS and Hart Crowser, Inc.

collected data for crude oil spills for the U.S. Beaufort Sea, the NPR-A, and Onshore Alaska North Slope east of the NPR-A from the following sources:

- British Petroleum (BP) Exploration (Alaska), Inc., electronic database files of oil spills in the Prudhoe Bay Unit Western Operating Area (1989 through 1996), Duck Island (Endicott) Unit (1989 through 1996), and Milne Point (1994 through 1996).
- BP Exploration (Alaska), Inc., electronic spreadsheet containing all industry and contractor oil spills from January 1997 to May 2001.
- Atlantic Richfield Company (ARCO) electronic spreadsheet files of oil spills for the Prudhoe Bay Unit Eastern Operating Area (1977 through 1996), Kuparuk River Unit (1977 through 1985 and 1986 through 1996), and Kuparuk River Unit exploration (1986 through 1996).
- Alyeska printed summary report of oil spills greater than 1,000 bbl along the TAPS from 1977 through 1989.
- Joint Pipeline Office electronic database of oil spills along the TAPS (1970 through 1994).
- Bureau of Land Management (BLM) printed reports of oil spills along the TAPS during 1981 and 1982.
- Alaska Department of Environmental Conservation (ADEC) electronic text and spreadsheet files of oil spills from the agency's current oil and hazardous substances spill database (July 1995 through February 1997) and an earlier oil and hazardous substances spill database (1971 through July 1995).
- Alaska Department of Environmental Conservation electronic spreadsheet containing all oil spills in their current oil and hazardous substance spill database to December 2000.
- An unattributed printed summary of oil spills over 100 gallons on the Alaska North Slope and along the TAPS from 1970 through 1981.
- An electronic spreadsheet summary of Alaskan and Canadian oil spills of 100 bbl or greater, from 1978 through 2000, as reported by the Oil Spill Intelligence Report.
- An MMS report that no oil spills of 100 bbl or larger have occurred in the Alaska Outer Continental Shelf Beaufort or Chukchi sea(s) study area.
- Alyeska electronic spreadsheet file containing all oil spills of 100 bbl or larger from the company's oil-spill database to September 1999.

A review of the reliability and completeness of the data for spills greater than or equal to 500 bbl (Hart Crowser, Inc. 2000) indicates that the available information was most reliable for 1985 through 2000, based on written documentation or lack of documentation and spills before that period. The MMS determined that spills greater than or equal to 100 bbl were documented and included in the database since 1985. In 1985, the ADEC began tracking spills in an electronic format. Although Hart Crowser, Inc. (2000) states that the database is complete for the years since production began, the BLM prefers to use 1985 as the starting point of reliability. Any uncertainty in documenting spills before that time is a concern because it is typical for spills to occur more frequently during field and pipeline startup.

Six crude oil spills greater than or equal to 500 bbl associated with onshore or offshore Alaska North Slope oil production occurred from 1985 to 2000. No spills greater than or equal to 1,000 bbl were documented during this time period. Of the six spills, one (i.e., a leak in either a 20- or 24-inch flow line from the wells in Kuparuk to the Central Processing Facility) is classified as a pipeline spill. The other five spills are classified as facility spills. The 2006 spill was from a 34

inch crude oil transit pipeline with an estimated volume of 201,000 gallons, +/- 33%, or 4800 bbls +/- 33%.

From 1985 to 2000, the median facility spill greater than or equal to 500 bbl on the Alaska North Slope was 663 bbl, and the mean (or average) was 680 bbl. The one pipeline spill had a volume of 510 bbl. For spill analysis, the largest recorded facility spill is used. The largest facility spill on record is 925 bbl. This oil spill analysis uses a pipeline spill of 4800 bbl. Rounded to the nearest 100 (to reflect the uncertainty associated with spill estimates), the hypothetical spill sizes become 900 bbl for the facility spill and 4800 bbl for the pipeline spill.

Historical Crude Oil Spills Greater Than or Equal to 500 Barrels From the Trans-Alaska Pipeline

The TAPS oil-spill analysis includes the pipeline and the pump stations, but excludes the Valdez marine terminal. Eight crude oil spills greater than or equal to 500 bbl associated with TAPS occurred from 1977 through 2001. Most large crude oil spills were associated with the start-up of the pipeline. No large spills greater than or equal to 1,000 bbl occurred from 1981 to 2000. On October 4, 2001, a bullet punctured the 48-inch TAPS mainline; approximately 6,800 bbl of crude oil were released from this intentional sabotage. Using the highest reported spill-quantity values, the mean (average) recorded crude oil spill greater than or equal to 500 bbl from 1977 to 2001 is 5,462 bbl, and the median is 4,381 bbl. Using the Alyeska Pipeline Service Company reported values, the mean and median spill sizes are 4,089 and 1,650, respectively. For spill analysis, the highest reported spill quantity mean is used and rounded to the nearest 100. Therefore, the mean hypothetical TAPS spill size is 5,500 bbl (median 4,400 bbl) for this oil spill analysis.

Historical Crude Oil Spills Greater Than or Equal to 1,000 Barrels from Tankers

Eleven crude oil spills greater than or equal to 1,000 bbl associated with the TAPS tankers have occurred from 1977 to 1999. The mean size for all TAPS tanker spills is 27,000 bbl and the median is 5,000 bbl. For in-port spills, the mean and median are 5,600 bbl and 5,300 bbl, respectively. For at-sea spills, the mean and median are 40,600 bbl and 4,900 bbl, respectively. The TAPS tanker spills are smaller than worldwide tanker spills and slightly smaller than tanker spills in U.S. waters (Anderson and Labelle 2000).

Historical Crude Oil Spills From Blowouts on the Alaska North Slope

The record for Alaska North Slope blowouts is not validated, but is presented as the best available information. There are two written reports regarding blowouts on the Alaska North Slope: Mallory (1998) and Fairweather (2000). Fairweather (2000) found 10 blowouts—six that Mallory had identified for the period 1974 to 1998 and four that occurred before 1974. Of the 10 blowouts, nine were gas and one was oil. The 1950 oil blowout was unspectacular and could not have been avoided, as there were no casings or blowout preventors available (Fairweather 2000). Drilling practices from 1950 would not be relevant today. A third study confirmed that no crude oil spills greater than or equal to 100 bbl from blowouts occurred from 1985 through 1999 (Hart Crowser, Inc. 2000). A recent report titled Blowout Frequency Assessment of Northstar (Scandpower AS 2001) uses statistical blowout frequencies modified to reflect specific field conditions and operative systems at Northstar. This report concludes that the blowout frequency for drilling in the oil-bearing zone at Northstar is 1.5 x 10-5 per well drilled. In comparison, the average statistical blowout frequency for a development well in the North Sea and U.S. Gulf of Mexico is 7.4 x 10-5 per well. This same report estimates that the statistical

frequency of a blowout spill with a size greater than 130,000 bbl is 9.4 x 10-5 per well drilled for Northstar.

However unlikely a blowout may be, it is an important concern to the public; therefore, the effects of a 120,000 bbl (15 day) spill are analyzed in **section 4.10** (Low Probability, Very Large Oil Spill).

K.1.1.2 Historical Large Crude Oil Spill Rates

Oil spill rates are the number of spills that occur over some exposure variable. The exposure variable can be bbl of oil produced or pipeline miles per year. Oil spill rates are estimated for the Alaska North Slope, the TAPS, and the TAPS tankers using historical spill data.

Alaska North Slope Spill Rate 1985-2000 Based on Volume

Only one Alaska North Slope facility or pipeline spill greater than or equal to 1,000 bbl from Alaska North Slope production has occurred since 1985. No documentation for crude oil spills greater than or equal to 100 bbl occurring prior to 1985 was found, but spill records dated prior to 1985 have not been validated as complete because of missing or incomplete documentation.

As noted above, five facility spills and one pipeline spill are documented from 1985 to 2000 and a large pipeline spill occurred in 2006. Total Alaska North Slope production was estimated to be 9.36 billion barrels (Bbbl) of crude oil and condensate (Alyeska Pipeline Service Company 2001, McMaines 2001). Anderson and LaBelle (2000) calculated Alaska North Slope spill rates from 1985 to 1998, hence they are slightly different from the spill rates calculated, using the 1985 to 2000 information, for this Supplement. The spill rate of 0.53 large spills per Bbbl handled was calculated for Alaska North Slope facility spills, using the entire record of five spills from 1985 to 2000. BLM and MMS use the 1985 to 2000 time period because spills greater than 100 bbl have been documented since 1985. In addition, the ADEC began an electronic database of oil spills in 1985. BLM and MMS consider the database most reliable from 1985 forward. The Alaska North Slope pipeline spill rate of 0.11 large spills per Bbbl handled was based on the record of one pipeline spill from 1985 to 2000. Including the spill in 2006, without considering the increased production that occurred in that additional time period, gives a very conservative figure of 0.22 spills per Bbl handled. The combined large crude oil spill rate for facilities and pipelines is 0.75 spills per Bbbl handled.

Trans-Alaska Pipeline Spill Rate 1977-2001 and 1985-2001 Based on Volume and Pipeline-Mile-Year

Flow in the TAPS began on June 20, 1977, with throughput of 112 million barrels (MMbbl) by the end of 1977. Throughput increased to almost 400 MMbbl in 1978, peaked at 744 MMbbl in 1988, and was 370 MMbbl in 2001. The estimated total volume transported through the TAPS during the period 1977 through 2001 is 13.62 Bbbl. The TAPS is 800 miles long.

1977-2001

There have been 12 crude oil spills greater than or equal to 100 bbl attributed to TAPS operation, four of which were less than 500 bbl. Eight spills were greater than or equal to 500 bbl, of which six were greater than or equal to 1,000 bbl. The last spill greater than or equal to 1,000 bbl occurred in 2001. The spill rate for spills greater than or equal to 500 bbl of 0.59 spills per Bbbl transported for TAPS was calculated based on the record of six accidental and two

sabotage spills over 13.62 Bbbl of production. The spill rate of 0.000425 large spills per pipeline-mile-year for TAPS was calculated based on the record of six accidental and two sabotage spills over 18,835 pipeline-mile-years during the period 1977 through 2001.

1985-2001

For purposes of this oil spill analysis, approximately the same time period (1985-2001) and the same class size (greater than or equal to 500 bbl) as the Alaska North Slope data in **section K.1.1.1, *Historical Large Crude Oil Spills***, are used. The spill rate of 0.21 large spills per Bbbl transported for TAPS was calculated based on two spills over 9.7 Bbbl of oil transported. The TAPS spill rate is 0.00015 large spills per pipeline-mile-year. The rate was also calculated based on two spills over 13,605 pipeline-mile-years from 1985 to 2001.

Trans-Alaska Pipeline Tanker Spill Rate 1977-1999 Based on Volume

Eleven tanker spills occurred in association with the transportation of Alaska North Slope crude: the Exxon Valdez spill and 10 other spills less than or equal to 15,000 bbl (Anderson and LaBelle 2000). No large spills have occurred since 1991. The spill rate of 0.87 spills per Bbbl transported was calculated based on the record of 11 accidental spills over 12.6 Bbbl of production (Anderson and LaBelle 2000).

K.1.1.3 Estimated Mean Number and Probability of One or More Large Crude Oil Spills for the Northeast National Petroleum Reserve – Alaska

The mean number of large crude oil spills, estimated over the production life of the planning area for Alternative A, Alternative B, Alternative C, and Alternative D are shown in Table K-2. The mean number of spills is derived from the projected resource volumes and the historic spill rate. The estimated total spill volume in Table K-2 is the total volume for all of the spills estimated for the given alternative. For instance, if two spills of 4800 bbl each were likely to occur, then the estimated total spill volume would be 9600 bbl.

Table K-2. Large Crude Oil Spills Estimated Over the Production Life of the Northeast National Petroleum Reserve – Alaska

Alternative	Resources (Bbbl)	Spill Rate (Spills/Bbbl)	Assumed Spill Size (bbl)	Estimated Mean Number of Spills[1]	Estimated Total Spill Volume[2] (bbl)
Crude Oil					
A	2.9	0.75	4,800	2.175	10,440
B	3.35	0.75	4,800	2.513	12,062
C	4.05	0.75	4,800	3.038	14,582
D	3.7	0.75	4,800	2.775	13,320

[1] The estimated mean number of oil spills is based on the estimated resource volume multiplied by the spill rate.
[2] The estimated total spill volume is the total volume for all of the estimated spills for the given alternative and price of oil.

The projected mean number of spills (listed in Table K-1) is used to estimate the chance of one or more large spills occurring.

K.1.2 Probability of a Small Crude Oil Spill - Less Than 500 Barrels

A total small spill rate of approximately 618 spills per Bbbl handled, calculated from the Alaska North Slope record of small spills, is used here. This spill rate consists of 178 small crude oil spills per Bbl and 440 small refined product spills per Bbbl. Since the companies and regulators that now operate onshore will likely participate onshore in the Northeast NPR-A, it seems reasonable to assume that the spill rate in the Northeast NPR-A will be similar to the rate on the Alaska North Slope.

Historical oil spill information and simple statistical methods are used to derive the following information about small crude and refined oil spills that occur on the Alaska North Slope:

- estimates of how often a spill occurs for every Bbbl of oil produced (oil-spill rates);
- estimates of the mean number of oil spills; and
- estimates of the mean and median size of oil spills from facilities, pipelines, and flow lines combined.

This information is used to estimate the number, size, and distribution of operational small spills that may occur in the planning area.

The historical information consists of crude and refined oil spills reported to the ADEC and the Joint Pipeline Office by the oil industry. Crude and refined oil spill rates and patterns from Alaska North Slope oil and gas exploration and development activities are determined for spills greater than or equal to one gallon and less than 500 bbl. Refined oil includes aviation fuel, diesel fuel, engine lubricants, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil. The Alaska North Slope oil spill analysis includes onshore and offshore oil and gas exploration and development spills from the Point Thompson Unit, Badami Unit, Kuparuk River Unit, Milne Point Unit, Prudhoe Bay West Operating Area, Prudhoe Bay East Operating Area, and Duck Island Unit.

Oil spill information is provided to the ADEC by private industry in accordance with State of Alaska Regulations, 18 AAC § 75. The ADEC figures are based on initial spill reports and may not contain updated information. Because of increased scrutiny after the Exxon Valdez oil spill, information in the ADEC database is most reliable for 1989 and later. Even though the integrity of the database cannot be validated thoroughly, the information in the database is still valuable because it is the only available data on small spills. For this oil spill analysis, ADEC records were spot checked against spill records from ARCO Alaska and BP. All spills greater than or equal to one gallon and less than 500 bbl occurring in the 1989 through 2000 time period were included in the oil spill analysis. A simple analysis of operational small oil spills was performed, and spill rates were estimated without regard to differentiating operation processes. The ADEC database structure does not facilitate quantitative analysis of Alaska North Slope oil spill rates separately for platforms, pipelines, or flow lines without further documentation and validation.

K.1.2.1 Historical Small Crude Oil Spill Rates and Patterns on the North Slope

Because this analysis of crude oil spills was performed collectively for all Alaska North Slope facilities, pipelines, and flow lines, the pattern that emerged was one of numerous small spills. Of the crude oil spills that occurred between 1989 and 2000, the ADEC database indicates that:

- 18% were less than or equal to 1 gallon;
- 54% were less than or equal to 5 gallons; and
- 99% were less than 25 bbl.

The small spill sizes in the database range from less than 1 gallon to 425 bbl. The mean crude oil spill size on the Alaska North Slope is 2.7 bbl, and the median spill size is 5 gallons. For purposes of the oil spill analysis in this Supplement, a mean crude oil-spill size of 3 bbl is assumed for small spills.

The database indicates that the causes of small crude oil spills on the Alaska North Slope, in decreasing order of frequency, are:

- leaks
- faulty valves/gauges
- vent discharges
- faulty connections
- ruptured lines
- seal failures
- human error
- explosions

Approximately 30% of the spills in the database do not include information on the causes.

The estimated small crude oil spill rate for the Alaska North Slope is 178 spills per Bbbl produced. The mean number, size, and total volume of small spills for each of the alternatives are shown in Table K-3. For this oil spill analysis, the mean number of small spills is used as the assumed number of spills.

Table K-3. Small Crude Oil Spills Estimated Over the Production Life of the Northeast National Petroleum Reserve – Alaska

Alternative	Resources (Bbbl)	Spill Rate (Spills/Bbbl)	Assumed Spill Size (bbl)	Estimated Mean Number of Spills[1]	Estimated Total Spill Volume (bbl)
Crude Oil					
A	2.9	178	3	516	1,548
B	3.35	178	3	596	1,782
C	4.05	178	3	721	2,163
D	3.7	178	3	659	1,977

[1] The estimated mean number of oil spills is based on the estimated resource volume multiplied by the spill rate and is rounded to the nearest whole number.

K.1.2.2 Historical Small Refined Oil Spill Rates and Types of Spills on the North Slope

Typical refined products spilled are aviation fuel, diesel fuel, engine lube, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil. On the Alaska North Slope, diesel spills represent 61% of refined oil spills by frequency and 75% by volume. Engine lube oil spills are 10% by frequency and 3% by volume. Hydraulic oil spills are 26% by frequency and 10% by volume. All other categories of spills are less than 1% by frequency and volume. Refined oil

spills occur in conjunction with oil exploration and production, and correlate to the volume of Alaska North Slope crude oil produced. As production of crude oil has declined, so has the number of refined oil spills. However, this apparent relationship could be coincidental, as emphasis on pollution prevention has also increased in the last several years. From 1989 to 2000, the spill rate for refined oil was 440 spills per Bbbl produced.

The mean number of refined oil spills during the lifetime of the alternatives is shown in Table K-8.

Table K-4. Small Refined Oil Spills <500 bbl Estimated Over the Production Life of the Northeast National Petroleum Reserve – Alaska

Alternative	Resources (Bbbl)	Spill Rate (Spills/Bbbl)	Assumed Spill Size (bbl)[1]	Estimated Mean Number of Spills[2]	Estimated Total Spill Volume (bbl)
A	2.9	440	0.7	1,276	893
B	3.35	440	0.7	1,474	1,032
C	4.05	440	0.7	1,782	1,247
D	3.7	440	0.7	1,628	1,140

[1] The mean spill size for refined spills on the Alaska North Slope from 1989 through 2000; equivalent to 29 gallons.
[2] The fractional estimated mean spill number and volume are rounded to the nearest whole number.

K.1.3 Probability of a Very Large Oil Spill - Greater Than or Equal to 120,000 Barrels

Size assumptions for very large spills for planning area facilities and pipelines are based on response planning standards and discharge estimates for the Alpine oil field (ARCO Alaska 1999, Phillips 2001). Blowouts are unlikely events. While blowouts are often equated with catastrophic spills, very few blowout events have resulted in spilled oil, and the volumes that are spilled are often small.

K.2 Oil Weathering and Spreading

Information about oil weathering and the aerial extent of an oil spill were estimated from oil weathering models and historical information.

K.2.1 Modeling Simulations of Oil Weathering

To judge the effect of an oil spill, the following volumes must be estimated:

- the amount of oil that evaporates;
- the amount of oil that disperses; and
- the amount of oil that remains after a certain time period.

Alpine field crude oil was used as the analog of oil types in the planning area. Weathering estimates of Alpine field crude oil and Arctic diesel (over a 30-day period) were derived by the SINTEF Oil Weathering Model (OWM), Version 2.0 (Reed et al. 2000).

Individual weathering results for Alpine field crude oil spills from the SINTEF OWM model are shown in Table K-5 and Table K-6. The SINTEF OWM changes both oil properties (density, viscosity, pour point, flash point, and water content) and physical properties (spreading,

evaporation, oil-in-water dispersion, and water uptake) of the oil. The OWM performs a 30-day time horizon on the model weathering calculations, but with a warning that the model is not verified against experimental field data for more than 4 to 5 days. The SINTEF OWM has been tested extensively with results from three full-scale field trials of experimental oil spills (Daling and Strom 1999).

The SINTEF OWM does not incorporate the effects of:

- currents
- beaching
- containment
- photo-oxidation
- microbiological degradation
- adsorption to particles
- encapsulation by ice

The spill sizes chosen for oil weathering were 500 and 900 bbl for the Alpine field-type crude oil spill, and 900 bbl for a diesel spill. Two general scenarios were simulated—one in which oil spills into open water, and another in which oil freezes into the ice and melts into 50% ice cover. It was assumed that open water occurs July through September, and that a winter spill melts out in July. For open water, the weathering of the 500- and 900-bbl spills was modeled as instantaneous spills. For the meltout spill scenario, the entire spill volume was modeled as an instantaneous spill. Although different amounts of oil could melt out at different times, the MMS assumed a conservative approach–all oil was released at the same time. Results are reported for the end of 1, 3, 10, and 30 days. The assumed fate and behavior of Alpine field crude oil and diesel oil, information that was used in the analysis of the effects of oil on environmental and social resources, are summarized in Table K-5 and Table K-6.

Table K-5. Fate and Behavior of a Hypothetical 500 bbl Oil Spill From Lagoon Pipelines.[1]

Features	Summer Spill[2]				Meltout Spill[3]			
Time after spill in days	1.0	3.0	10.0	30.0	1.0	3.0	10.0	30.0
Oil remaining (percent)	75.4	68.0	44.0	38.0	77.0	71.9	64.3	57.6
Oil dispersed (percent)	0.6	2.0	8.0	22.0	0.0	0.1	0.7	2.4
Oil evaporated (percent)	24.0	30.0	36.0	40.0	23.0	28.0	35.0	40.0
Thickness (mm)	3.1	1.9	1.1	1.0	4.6	2.7	1.5	1.0
Discontinuous area (mi^2)[4]	0.6	3.1	15.5	63.9	0.6	4.3	10.5	83.0
Estimated coastline oiled (mi)[5]	10.5				9.9			

[1] Calculated with the SINTEF Oil Weathering Model Version 2.0 (Reed et al. 2000), assuming an Alpine field crude type.
[2] Summer (July through September) and assumes: 12-knot wind speed, 33 degrees Fahrenheit, and 1.3-feet (0.4-meter) wave height.
[3] Spill is assumed to occur in May into first-year ice, pools 0.8 inches (2 cm) thick on ice surface for 2 days at 32 degrees Fahrenheit before meltout into 50 percent ice cover, 11-knot wind speed, and 0.3 feet (0.1 meter) wave heights.
[4] Calculated from Equation 6 of Table 2 in Ford (1985), and is the discontinuous area of a continuing spill or the area swept by an instantaneous spill of a given volume. Ice dispersion occurs for about 30 days before meltout.
[5] Calculated from Equation 17 of Table 4 in Ford (1985), and is the result of stepwise multiple regression for length of historical coastline affected.

The structure of the ADEC Alaska North Slope spill database does not facilitate a quantitative analysis of pipeline spill rates for small spills. The ADEC database specifically identifies five pipeline leaks among 975 spill records. The volumes of these pipeline leaks are 0.7, 5, 18, 125,

and 510 bbl. Additionally, any spills occurring or moving off pads would have some potential to enter a river or water body. For the purposes of this oil spill analysis, the percent of crude oil spills occurring on a pad versus off the pad and onto the surrounding environment was estimated. Approximately 65 to 80% of all crude oil spills would occur on a pad and have little or no effect on the environment. Approximately 20 to 35% could occur in or reach the surrounding environment.

Table K-6. Fate and Behavior of a Hypothetical 900 bbl Oil Spill From a Lagoon Facility.[1]

Features	Summer Spill[2]				Meltout Spill[3]			
Time after spill in days	1	3	10	30	1	3	10	30
Oil remaining (percent)	75.5	68.4	57.9	40	76.9	71.8	64	56.5
Oil dispersed (percent)	0.5	1.6	6.1	20	0.1	0.2	1	3.5
Oil evaporated (percent)	24	30	36	40	23	28	35	40
Thickness (millimeters)	4.1	2.5	1.5	1	6.1	3.9	1.9	1.2
Discontinuous area (square miles)[4]	0.6	4.3	21.1	86.8	1.2	5.6	26.7	112.2
Estimated coastline oiled (miles)[5]	13.6				13.0			

[1] Calculated with the SINTEF Oil Weathering Model Version 2.0 (Reed et al. 2000), assuming an Alpine field crude type.
[2] Summer (July through September) assumes: 12-knot wind speed, 33 degrees Fahrenheit, and 1.3-feet (0.4-meter) wave height.
[3] Spill is assumed to occur in May into first-year ice, pools 0.8 inches (2 cm) thick on ice surface for 2 days at 32 degrees Fahrenheit before meltout into 50 percent ice cover, 11-knot wind speed, and 0.3 feet (0.1 meter) wave heights.
[4] Calculated from Equation 6 of Table 2 in Ford (1985), and is the discontinuous area of a continuing spill or the area swept by an instantaneous spill of a given volume. Ice dispersion occurs for about 30 days before meltout.
[5] Calculated from Equation 17 of Table 4 in Ford (1985), and is the result of stepwise multiple regression for length of historical coastline affected.

K.2.2 Observations of Historic North Slope Spill Patterns

The development scenarios for alternatives A, B, C, and D include an onshore pipeline. Of greatest concern would be the possible contamination of the Colville River, because a pipeline could cross or underlie the Colville River and some of its tributaries, and Teshekpuk Lake.

Those spills reaching the surrounding environment generally remain restricted to a limited area of the tundra unless they reach a river, stream, or other water body. The ADEC records are not accurate enough to provide statistical spill size areas. The following are comments based on information from the ADEC database and Behr-Andres et al. (2001). Off-pad spills that occur in or reach the environment generally cover a small area (less than or equal to 500 ft^2). Larger areas of contamination occur when wind blows a fine oil mist over a large area. The largest area ever covered was the result of a pipeline spill on December 30, 1993, at drill site 5, well 23, which misted a fine oil spray of 4 bbl over a tundra area of 100 to 145 acres (Mueller 1997). Crude oil from a failed flowline spilled onto a gravel pad, reserve pit, and impoundment. High winds resulted in the crude oil being misted over the snow-covered tundra in an area approximately 330 feet wide and 1,300 feet long (Behr-Andres et al. 2001). Of the off-pad spills that occur, many contact snow or ice, which is cleaned up before the oil reaches the tundra. Smaller spills are likely to be contained within the snow layer, depending on snow depth and density. Larger spills are more likely to reach the ground surface. The ADEC database documents that a spill at Point McIntyre covered approximately 23 acres of snow-covered tundra with 142 bbl of crude oil. Because this area was snow covered, there was little impact to

the surrounding environment. If this spill had occurred during the summer, the impacts would have been very different.

K.3 Cumulative Analysis of Oil Spills

This section discusses how the oil spills for Effects of the Cumulative Case (**section 4.7**) were estimated.

K.3.1 Preparing the Cumulative Analysis

The TAPS pipeline, onshore Alaska North Slope, TAPS tankers, and the Alaska Outer Continental Shelf have varying spill rates and spill-size categories. For a summary of the spill rates and spill size categories that were assumed for analysis of oil spills in the cumulative case, see Table K-7. One noteworthy fact is that most oil originating from either onshore or offshore on the North Slope of Alaska flows through the TAPS pipeline and into TAPS tankers.

Table K-7. Oil Spill Rates and Spill-size Categories Used to Estimate Large Crude Oil Spills for the Cumulative Analysis

Location	Beaufort OCS		Alaska North Slope 1985-2001		TAPS Pipeline 1985-2001		TAPS Tanker 1977-1999	
	Spill Rate (Spills/Bbbl)	Size Category (bbl)	Spill Rate (Spills/Bbbl)	Size Category (bbl)	Spill Rate (Spills/Bbbl)	Size Category (bbl)	Spill Rate (Spills/Bbbl)	Size Category (bbl)
Offshore	0.23	≥1,000	-	-	0.21	≥500	0.88	≥1,000
Onshore	-	-	0.64	≥500	0.21	≥500	0.88	≥1,000

Sources: Anderson and LaBelle (2000), Bercha Group, Inc. (2002), and USDOI MMS (2002).

Estimates of past, present, and reasonably foreseeable production are used for the quantitative analysis of oil spills. Past, present, and reasonably foreseeable production contributes 14.4 Bbbl in reserves and resources, with the planning area contributing an additional 1.5 Bbbl (the mean resource value for the planning area), for a total of 15.9 Bbbl.

K.3.2 Estimating Possible Future Spills From All Sources

The estimated mean number and volume of spills for the cumulative case are shown in Table K-8. The likely number of additional oil spills in the Beaufort Sea, onshore, along the TAPS pipeline, or tanker route due to projects in the planning area is two. Thus, for purposes of analysis of the cumulative case, it is assumed that the planning area would contribute a total of two additional oil spills offshore in the Beaufort Sea, onshore, or along the TAPS pipeline or tanker route.

The Beaufort Sea pipeline and platform spill size range used in the analysis is 1,500 to 4,600 bbl. The onshore spill size range used is 500 to 900 bbl. For the cumulative case, a TAPS pipeline spill of 4,400 bbl is estimated. The average spill sizes from TAPS tankers and the distribution of the number of spills used for this analysis is as described in the Northwest National Petroleum Reserve – Alaska IAP/EIS (USDOI BLM and MMS 2003).

It is estimated that one spill greater than or equal to 1,000 bbl would occur as a result of activities in the Beaufort Sea over the lifetime of planning area projects. This estimate is based on production from past, present, and reasonably foreseeable development. Possible offshore

sources in these categories (past, present, and reasonably foreseeable development) include Endicott, Northstar, Kalubik, Gwydyr Bay, Flaxman Island, Liberty, Kuvlum, and Hammerhead. This estimate also includes potential production from undiscovered resources on Federal leased tracts in the Beaufort Sea.

It is estimated that eight spills greater than or equal to 500 bbl would occur onshore before entering the TAPS pipeline. One of these spills is likely to be related to planning area projects.

It is estimated that three spills greater than or equal to 500 bbl would occur along the TAPS pipeline, although it is unlikely that the additional throughput given planning area projects would increase the number of spills.

Fourteen spills greater than or equal to 1,000 bbl are expected to occur as a result of projects along the TAPS tanker route, one would be expected to be due to the additional volume from planning area projects. Of these:

- nine spills with a mean size of 4,000 bbl—four in port and two at sea—would be expected to occur;
- four spills with a mean size of 13,000 bbl would be expected to occur at sea; and
- one spill with a size ranging from 200,000 to 260,000 bbl (for purposes of analysis 250,000 bbl) would be expected to occur at sea.

Previous studies show that the chance of one or more spills both occurring and contacting land along the U.S. coast adjacent to the TAPS tanker route is less than or equal to 3% (LaBelle et al. 1996).

Table K-8. Cumulative Oil-Spill-Occurrence Estimates ≥500 bbl and ≥1,000 bbl over Assumed 15-20 Year Production Life of the Northeast National Petroleum Reserve – Alaska

Spill Location and Timeframe	Crude-Oil Spills					
	Reserves and Resources (Bbbl)	**Spill Rate (Spills/ Bbbl)**	**Size Category**	**Assumed Size (bbl)**	**Most Likely Number**	**Estimated Mean Number of Spills**
Offshore						
Past, present, and reasonably foreseeable	2.80	0.23	≥1,000 bbl	NA	1	0.64
Planning Area	NA	0.23	≥1,000 bbl	NA	NA	NA
Total	**2.80**	**0.23**	**≥1,000 bbl**	NA	**1**	**0.64**
Onshore						
Past, present, and reasonably foreseeable	11.6	0.64	≥500 bbl	500–900	7	7.42
Planning Area	1.5	0.64	≥500 bbl	500–900	1	0.96
Total	**13.1**	**0.64**	**≥500 bbl**	**500–900**	**8**	**8.38**
TAPS (Pipeline)						
Past, present, and reasonably foreseeable	14.4	0.21	≥500 bbl	4,400	3	3.02
Planning Area	1.5	0.21	≥500 bbl	4,400	0	0.32
Total	**15.9**	**0.21**	**≥500 bbl**	**4,400**	**3**	**3.34**
TAPS (Tanker)						
Past, present, and reasonably foreseeable	14.4	0.88	≥1,000 bbl	varies	13	12.67
Planning Area	1.5	0.88	≥1,000 bbl	varies	1	1.32
Total	**15.9**	**0.88**	**≥1,000 bbl**	**varies**	**14**	**13.99**

Note: The ADEC database has no significant crude oil spills on the North Slope resulting from well blowouts and no facility or onshore pipeline spills greater than 1,000 barrels for the years 1985-2000.
NA = Data not available or not applicable.
Source: USDOI MMS (2002).

K.4 Bibliography for Appendix K

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Glossary

GLOSSARY

GLOSSARY

A

Acidophilus: Acid-loving (as in bacteria or plants); growing well in an acid medium.

Active floodplain: The flat area along a waterbody where sediments are deposited by seasonal or annual flooding; generally demarcated by a visible high water mark.

Aerial: Consisting of, moving through, found in, or suspended in the air.

Alluvial: Sedimentary material consisting mainly of coarse sand and gravel.

Alternatives: The different means by which objectives or goals can be attained. One of several policies, plans, or projects proposed for decision making.

Ambient: A term used to describe the environment as it exists at the point of measurement and against which changes (impacts) are measured.

Ambient air quality standard: Air pollutant concentrations of the surrounding outside environment that cannot legally be exceeded during fixed time intervals within a specific geographic area.

Amphidromous: A term used to describe fish that spawn and overwinter in rivers and streams, but migrate during the ice-free summer from these freshwater environments into coastal waters months to feed.

Anadromous: A term used to describe fish that mature in the sea and swim up freshwater rivers and streams to spawn. Salmon, steelhead, and sea-run cutthroat trout are examples.

Anticline: An inverted bowl-shaped structure formed when sedimentary rock layers are folded to produce an arch or elongated dome.

Anoxic: The condition of an environment in which free oxygen is lacking or absent.

Anthropogenic: Of, relating to, or resulting from the influence of human beings on nature.

Aquatic: Growing, living in, frequenting, or taking place in water; in this Amended IAP/EIS, used to indicate habitat, vegetation, and wildlife in freshwater.

Aromatic hydrocarbon: A hydrocarbon with a molecular structure involving one or more benzene unsaturated resonant rings of six carbon atoms, and having properties similar to benzene, which is the simplest of the aromatic hydrocarbons.

Archaeological resource: Place(s) where the remnants (e.g., artifacts) of a past culture survive in a physical context that allows for the interpretation of these remains. Archaeological resources can be districts, sites, buildings, structures, or objects and can be prehistoric or historic in nature.

Aufeis: Thick ice that builds up as a result of repeated overflow.

Authorized Officer (AO): Designated agency personnel responsible for a certain area of a project; for the Northeast National Petroleum Reserve – Alaska, generally the BLM State Director.

B

Barrel: Unit of measurement consisting of 42 gallons of oil or other fluid.

Baseline data: Data gathered prior to the proposed action to characterize pre-development site conditions.

Biodegradable: Capable of being broken down by the action of living organisms such as micro-organisms.

Biological Assessment (BA): A document prepared by or under the direction of a federal agency; addresses listed and proposed species and designated and proposed critical habitat that may be present in the action area, and evaluates the potential effects of the action on such species and habitat.

Black water: Discharge that includes wastewater from any or all of the following: toilets, urinals, sewage treatment systems.

Bonding capacity: An amount, determined by market analysts, based on a government entity's prior bonding experience, actual repayment performance, and its ability to service future, periodic debt. It affects the ability of municipalities to issue and sell bonds to generate funds for capital improvements.

Bore-hole: The opening in the ground that is created when drilling a well; may refer to the inside diameter of the bore-hole wall, the rock face that bounds the drilled hole.

Bottomfast ice: Ice that is firmly attached or grounded to the bottom of a water body, which is often frozen from top to bottom.

Brackish: Water that is intermediate between salt and fresh water; often occurs at the mouths of rivers, where fresh water mixes with salt water.

Brine: General description of water that is produced with oil. The water is associated with the oil-producing formation and can have varying amounts of dissolved salts.

Brood: A group of young birds being cared for by an adult bird; generally the surviving hatchlings from one or more clutches of eggs.

Bureau of Land Management (BLM): An agency of the United States government, under the Department of the Interior, responsible for administering certain public lands of the United States.

Burin: A tool flaked into a chisel point for inscribing or grooving bone, wood, leather, stone, or antler.

C

Calving area: A large area where large mammals, particularly ungulates such as caribou, congregate to give birth to their young.

Capital expenses: The money spent to purchase or upgrade physical assets, such as buildings or machinery.

Carrion: Dead or dying flesh of animals.

Council on Environmental Quality (CEQ): An advisory council to the President of the United States; established by the National Environmental Policy Act of 1969. It reviews federal programs for their effect on the environment, conducts environmental studies, and advises the President on environmental matters.

Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA): An act that provided the authority for money administered by the Environmental Protection Agency to identify and clean up hazardous waste sites; also known as Superfund.

Code of Federal Regulations (CFR): A codification of the general and permanent rules published in the Federal Register by the executive departments and agencies of the federal government.

cfs: Cubic feet per second; 1 cfs equals 448.33 gallons per minute.

Commercial field: Oil or natural gas fields that can be produced such that they provide a suitable return on investment.

Commercial oil (or natural gas) reserves: Oil or natural gas reserves that can be produced such that they provide a suitable return on investment.

Commercially recoverable: See commercial oil (or natural gas) reserves.

Concern: A point, matter, or question raised by management or the public that must be addressed in the planning process.

Conglomerate: Sedimentary rock consisting of gravel and small boulders.

Consistency determination: A finding by a state or federal agency that a project or agency action is consistent with a required agency program, guideline, or regulation, such as the Alaska Coastal Zone Management Program.

Consultation: Exchange of information and interactive discussion; when the "C" in consultation is capitalized it refers to consultation mandated by statute or regulation that has prescribed parties, procedures, and timelines (e.g. Consultation under NEPA or Section 7 of the Endangered Species Act).

Criteria: Data and information that are used to examine or establish the relative degrees of desirability of alternatives or the degree to which a course of action meets an intended objective.

Cultural resources: The remains of sites, structures, or objects used by humans in the past, historic or prehistoric. More recently referred to as heritage resources.

Cumulative effects or impacts: The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonable foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such actions. Cumulative impacts can result from individually minor, but collectively significant actions, taken place over a period of time.

D

Demersal: Living near, deposited on, or sinking to the seabed.

Density: The number of individuals per a given unit area.

Deposit: A natural accumulation, as of precious metals, minerals, coal, gas, and oil that may be pursued for its intrinsic value; gold deposit.

Development: The phase of petroleum operations that occurs after exploration has proven successful, and before full-scale production. The newly discovered oil or gas field is assessed during an appraisal phase, a plan to fully and efficiently exploit it is created, and additional wells are usually drilled.

DEW-Line: Distant Early Warning Site. A site designed and built during the Cold War as the primary line of air defense warning of "Over the Pole" invasion of the North American Continent.

Dilution: The act of mixing or thinning, and therefore decreasing a certain strength or concentration.

Dispersion: The act of distributing or separating into lower concentrations or less dense units.

Dissociable: Able to break up into simpler chemical constituents.

Diversity: An expression of community structure; high if there are many equally abundant species; low if there are only a few equally abundant species. The distribution and abundance of different plant and animal communities and species within the area covered by a land and resource management plan.

Draft Environmental Impact Statement (DEIS): The draft statement of the environmental effects of a major federal action which is required under Section 102 of the National Environmental Policy Act, and released to the public and other agencies for comment and review.

Drilling fluid (mud): A preparation of water, clay, and chemicals circulated in a well during drilling to lubricate and cool the drill bit, flush rock cuttings to the surface, prevent

sloughing of the sides of the hole, and prevent the flow of formation fluids into the bore-hole or to the surface.

Drilling pad: A temporary drilling site, usually constructed of local materials such as gravel.

Duck pond: A small, flat-bottomed plastic receptacle placed under a vehicle to catch and contain any contaminated fluids that may melt or drip from the underside of the vehicle.

E

Economically recoverable: See commercially recoverable.

Effect: Environmental change resulting from a proposed action. Direct effects are caused by the action and occur at the same time and place, while indirect effects are caused by the action but are later in time or further removed in distance, although still reasonably foreseeable. Indirect effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density, or growth rate, and related effects on air and water and other natural systems, including ecosystems. Effect and impact are synonymous as used in this document.

Employment: Labor input into a production process, measured in the number of person-years or jobs; the number of jobs required to produce the output of each sector. A person-year is approximately 2,000 working hours by one person working the whole year or by several persons working seasonally. A job may be 1 week, 1 month, or 1 year.

Endangered species: Any species of animal or plant that is in danger of extinction throughout all or a significant portion of its range; plant or animal species identified by the Secretary of the Interior as endangered in accordance with the 1973 Endangered Species Act.

Energy budget: The flow of energy through an organism or ecosystem. For an organism, it is the amount of energy being absorbed (e.g., food) in relation to the amount of energy expended and lost as heat.

Environment: The physical conditions that exist within an area (e.g., the area that will be affected by a proposed project), including land, air, water, minerals, flora, fauna, ambient noise, and objects of historical or aesthetic significance. The sum of all external conditions that affect an organism or community to influence its development or existence.

Environmental Assessment (EA): A concise public document, for which a federal agency is responsible, that serves to: 1) briefly provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact; 2) aid an agency's compliance with the National Environmental Policy Act when no environmental impact statement is necessary; and, 3) facilitate preparation of an environmental impact statement when one is necessary.

Environmental Justice: The fair treatment and meaningful involvement of all people, regardless of natural origin or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socio-economic groups, should bear a disproportionate share of the negative environmental consequences resulting from

industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies. Executive Order 12898 directs federal agencies to achieve environmental justice as part of their missions by identifying and addressing disproportionately high adverse effects of agency programs, policies, and activities, on minority and low-income populations.

Environmental Impact Statement (EIS): An analytical document prepared under the National Environmental Policy Act (NEPA) that portrays the potential impacts to the environment of a Preferred Action and its possible alternatives. An EIS is developed for use by decision-makers to weigh the environmental consequences of a potential decision.

Erosion: The wearing away of the land surface by running water, wind, ice, or other geologic agents, including gravitation creep.

Eskimo: An ethnonym (name given to a group by another group) referring to speakers of the Inuit language family who live in the Arctic and Subarctic regions of North America (e.g., Canada, Greenland and Alaska) and eastern Siberia.

Essential Fish Habitat (EFH): As defined by Congress in the interim final rule (62FR 66551): "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." For the purpose of interpreting the definition of EFH habitat, "waters" include aquatic areas and their associated physical, chemical, and biological properties; "substrate" includes sediment underlying the waters; "necessary" refers to the habitat required to support a sustainable fishery and the managed species contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers all habitat types utilized by a species throughout its life cycle.

Estuary: An estuary is a partially enclosed body of water formed where freshwater from rivers and streams flows into the ocean, mixing with the salty seawater. Estuaries and the lands surrounding them are places of transition from land to sea, and from fresh to salt water.

Ethnographic: Of or pertaining to the descriptive and analytical study of the culture of particular self-defined groups or communities.

Exploration: The search for economic deposits of minerals, gas, oil or coal through the practices of geology, geochemistry, geophysics, drilling, shaft sinking, and/or mapping.

F

°F: Degrees Fahrenheit.

Fast-ice zone: Area along the coast covered by sea ice that is continuous with and attached to the shoreline.

Feasible: Capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, legal, social, and technological factors.

Final Environmental Impact Statement (Final EIS): A revision of the Draft Environmental Impact Statement that includes public and agency comments on the draft.

Fisheries habitat: Streams, lakes, and reservoirs that support fish populations.

Fishery: The act, process, occupation, or season of taking an aquatic species.

Floodplain: The lowland and relatively flat area adjoining inland waters, including, at a minimum, that area subject to a 1 percent or greater chance of flooding in any given year.

Fluvial: Of or relating to a stream or river.

Fossil: Evidence or remnant of a plant or animal preserved in the earth's crust (e.g., skeleton, footprint, or leaf print).

Fossil fuel: Petroleum, natural gas, and coal; fuel derived from biologic material that was deposited into sedimentary rocks.

Frequency: The number of samples in which a plant or animal species occurs divided by the total number of samples.

Fugitive dust: Dust particles suspended randomly in the air, usually from road travel, excavation, and/or rock loading operations.

G

Game Management Unit (GMU): A geographic division made by the Alaska Department of Fish and Game for the management of fish and wildlife in the State. Different GMUs have different hunting and fishing seasons, bag limits, and other harvest rules.

Geology: The scientific study of the origin, history, and structure of the earth; the structure of a specific region of the earth's surface.

Geomorphic: Pertaining to the structure, origin, and development of the topographical features of the earth's crust.

Gill net: Nets made of one or more layers of mesh, used to catch fish by entanglement as they attempt to swim through the net.

Glacial drift: Unsorted sediments deposited by glaciers and not subsequently reworked by water; coarse-grained materials (e.g., rock and sand) suspended in a fine-grained (e.g., silt) matrix. The term applies to all mineral material transported by a glacier and deposited directly by or from the ice, or by running water emanating from a glacier.

Global warming: An increase over time of the average temperature of the earth's atmosphere and oceans. It is generally used to describe the temperature rise over the past century or so, and the effects of humans on the temperature.

Gray water: Discharge that includes wastewater from any or all of the following: kitchen sink, shower, drinking water, and laundry.

Greenhouse gas: A gas, such as carbon dioxide or methane, that is relatively transparent to the higher-energy sunlight, but traps lower-energy infrared radiation. Greenhouse gases

have the ability to allow sunlight to warm the earth but trap the heat in, thereby potentially raising the earth's temperature. Greenhouse gases associated with the "greenhouse effect" and global warming.

Groundwater: Water found beneath the land surface in the zone of saturation below the water table.

H

Habitat: The natural environment of a plant or animal, including all biotic, climatic, and soil conditions, or other environmental influences affecting living conditions. The place where an organism lives.

Hazardous waste: As defined by the Environmental Protection Agency, a waste that exhibits one or more of the following characteristics: ignitability, corrosivity, reactivity, and/or toxicity. Hazardous wastes are listed in 40 CFR § 261.3 and 40 CFR § 171.8.

Headwaters: The upper reaches of a stream where the stream forms.

Hydrocarbon: A naturally occurring organic compound comprised of hydrogen and carbon. Hydrocarbons can occur in molecules as simple as methane (one carbon atom with four hydrogen atoms), but also as highly complex molecules, and can occur as gases, liquids, or solids. The molecules can have the shape of chains, branching chains, rings, or other structures. Petroleum is a complex mixture of hydrocarbons. The most common hydrocarbons are natural gas, oil, and coal.

Hydrologic system: The combination of all physical factors, such as precipitation, stream flow, snowmelt, and groundwater that affect the hydrology of a specific area.

I

Impermeable: Not permitting passage of fluids through its mass.

Impoundment: The collection and confinement, usually of water (in the case of mining, tailings materials), in a reservoir or other storage area.

Increment: An amount of change from an existing concentration or amount, such as air pollutant concentrations.

Indigenous: Having originated in and being produced, growing, living, or occurring naturally in a particular region or environment.

Indirect impacts: Impacts that are caused by an action, but are later in time or farther removed in distance, although still reasonably foreseeable.

Infrastructure: The underlying foundation or basic framework; substructure of a community (i.e., schools, police, fire services, hospitals, water, and sewer systems).

Insect-relief area: An area of the North Slope with relatively low numbers of insects that is used by caribou for relief from insects.

Interstitial ice: Ice found in cavities or lodged between soil grains or rock crevices.

Irretrievable: A term that applies to losses of production, harvest, or commitment of renewable natural resources. For example, some or all of the wildlife forage production from an area is irretrievably lost during the time an area is used as an oil or gas development site. If the use changes, forage production can be resumed. The production lost is irretrievable, but the act is not irreversible.

Irreversible: A term that applies primarily to the use of nonrenewable resources, such as minerals or cultural resources, or to those factors that are renewable only over long time spans, such as soil productivity. Irreversible also includes loss of future options.

Isobath: Depth interval contour, as commonly mapped for lake or ocean bottoms.

J

Jurisdictional wetland: A wetland area delineated and identified by specific technical criteria, field indicators, and other information, for the purposes of public agency jurisdiction. The U.S. Army Corps of Engineers regulates "dredging and filling" activities associated with jurisdictional wetlands. Other federal agencies that can become involved with matters that concern jurisdictional wetlands include the U.S. Department of Interior's Fish and Wildlife Service, the Environmental Protection Agency, and the Natural Resource Conservation Service.

K

L

Landfast ice: Stationary ice that is continuous with, and attached to, the shoreline and extends out into the waterbody.

Landform: Any physical, recognizable form or feature on the earth's surface having a characteristic shape, that is produced by natural causes. Landforms provide an empirical description of similar portions of the earth's surface.

Land management: The intentional process of planning, organizing, programming, coordinating, directing, and controlling land use actions.

Landscape: The sum total of the characteristics that distinguish a certain area on the earth's surface from other areas; these characteristics are a result not only of natural forces but also of human occupancy and use of the land. An area composed of interacting and interconnected patterns of habitats (ecosystems), which are repeated because of geology, landforms, soils, climate, biota, and human influences throughout the area.

Land status: The ownership status of lands.

Land use allocation: The assignment of a management emphasis to particular land areas with the purpose of achieving the goals and objectives of some specified use(s) (e.g., campgrounds, wilderness, logging, and mining).

Laterally discontinuous: Not continuous in the horizontal plane. For example, in an area with laterally discontinuous permafrost, the permafrost is not uniformly found across the entire area without interruption.

Lead: Long cracks in the ice, used by both whales and boats to travel through the water.

Liquid natural gas: Natural gas which has been liquefied by reducing its temperature to -260 °F at atmospheric pressure. It will remain as a liquid at -116 °F and 673 pounds per square inch above atmospheric pressure.

Listed species: Species that are listed as threatened or endangered under the Endangered Species Act of 1973 (as amended).

Long-term impacts: Impacts that normally result in permanent changes to the environment. An example is the loss of habitat due to development of a gravel pit. For each resource, the definition of long-term may vary.

M

Maktak*:* Eskimo delicacy consisting of the skin and the thin layer of subcutaneous fat of whales.

Management activity: A human activity imposed on a landscape for the purpose of harvesting, traversing, transporting, or replenishing natural resources.

Management area: An area delineated on the basis of management objective prescriptions.

Management concern: An issue, problem, or condition that influences the range of management practices identified in a planning process.

Management direction: A statement of multiple use and other goals and objectives, and the associated management prescriptions, standards, and guidelines for attaining them (36 CFR § 219.3).

Masu: A starchy tuber found in Arctic and Subarctic regions (vernacular is "Eskimo potato").

Mean: A statistical value calculated by dividing the sum of a set of sample values by the number of samples. Also referred to as the arithmetic mean or average.

Migratory: Moving from place to place, daily or seasonally.

Mitigation: Steps taken to: 1) avoid an impact altogether by not taking a certain action or parts of an action; 2) minimize an impact by limiting the degree or magnitude of the action and its implementation; 3) rectify an impact by repairing, rehabilitating, or restoring the affected environment; 4) reduce or eliminate an impact over time by preserving and

maintaining operations during the life of the action; and, 5) compensate for an impact by replacing or providing substitute resources or environments (40 CFR Part 1508.20).

Memorandum of Understanding (MOU): Usually documents an agreement reached amongst federal agencies.

N

National Environmental Policy Act (NEPA): An act declaring a national policy to encourage productive and enjoyable harmony between humankind and the environment; promote efforts to prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of humanity; enrich the understanding of the ecological systems and natural resources important to the nation; and establish a Council on Environmental Quality.

Net present value (NPV): The difference between the discounted value (benefits) of all outputs to which monetary values or established market prices are assigned and the total discounted costs of managing the planning area.

National Pollutant Discharge Elimination System (NPDES): A program authorized by Sections 318, 402, and 405 of the Clean Water Act, and implemented by regulations 40 CFR § 122. The NPDES program requires permits for the discharge of pollutants from any point source into waters of the United States.

No-Surface-Occupancy: An area that is open for mineral leasing but analysis has found that in order to protect other resource values, no surface occupancy is permitted for oil and gas facilities or infrastructure.

O

Objective: A concise, time-specific statement of measurable planned results that respond to pre-established goals. An objective forms the basis for further planning to define the precise steps to be taken and the resources to be used to achieve identified goals.

Oiled: Having oil on skin, fur, or feathers after coming into contact with an oil spill.

Ozone: Form of oxygen found largely in the stratosphere; a product of the reaction between ultraviolet light and oxygen.

P

Particulates: Small particles suspended in the air, generally considered pollutants.

Pelagic: Pertaining to the ocean and especially to animals (typically marine mammals, birds, or fish) that live at the surface of the ocean away from the coast.

Per capita income: Total income divided by the total population.

Performance-based stipulation: A stipulation applied to leases that provides a stated objective that must be met, along with requirements and guidelines, but provides some leeway as to how that objective can be met and maintained by the lessee; compare to prescriptive-based stipulation.

Permafrost: Permanently frozen ground.

Permanent oil and gas facilities: Production facilities, pipelines, roads, airstrips, production pads, docks, seawater treatment plants, and other structures associated with oil and gas production that occupy land for more than 1 winter season. Material sites and seasonal facilities, such as ice roads, are excluded, even when the pads are designed for use in successive winters.

Permeability: The property or capacity of a porous rock, sediment, or soil for transmitting a fluid; a measure of the relative ease of fluid flow under unequal pressure.

Photoperiod: In reference to cycles of light and darkness, the length of time that uninterrupted light is present, generally the length of daylight in a given 24 hour period.

Physiographic province: A region having a particular pattern of relief features or land forms that differs significantly from that of adjacent regions (e.g., Arctic Coastal Plain).

Pingo: A low conical hill or mound forced up by hydrostatic pressure in an area underlain by permafrost and consisting of an outer layer of soil covering a core of solid ice. Pingos range from 6 to 160 meters in height.

Planning Area: An administrative unit determined by the Bureau of Land Management based on resources and management issues. Large properties (such as the National Petroleum Reserve – Alaska) are divided into smaller planning areas so that studies and management decisions can be made on a more local level.

Plant community: A vegetation complex, unique in its combination of plants, which occurs in particular locations under particular influences. A plant community is a reflection of integrated environmental influences on the site, such as soils, temperature, elevation, solar radiation, slope aspect, and precipitation.

Pollution: Human-caused or natural alteration of the physical, biological, and radiological integrity of water, air, or other aspects of the environment that produces undesired effects.

Polygon: A surface landform resulting from repeated freeze-thaw cycles common in permafrost areas. Polygons are bounded by troughs of ice or water and generally occur in networks that form regular geometric designs with multiple square sides of nearly equal lengths.

Polynyas: Non-linear openings in the sea ice.

Porosity: The ratio of the volume of void space in a material (e.g., sedimentary rock or sediments) to the volume of its mass.

Potable: Suitable, safe, or prepared for drinking, as in potable water.

Pot hunting: The removal or theft of artifacts from cultural resource sites by untrained individuals for profit and recreation.

Prescriptive-based stipulation: A stipulation applied to leases with exacting requirements applying to lessee activities; compare to performance-based stipulation.

Prevention of significant deterioration (PSD): A special permit procedure established in the Clean Air Act, as amended, used to ensure that economic growth occurs in a manner consistent with the protection of public health and preservation of air quality related values in national special interest areas.

Pristine: Pure, original, and uncontaminated.

Prospect: An area of exploration in which hydrocarbons have been predicted to exist in commercially recoverable quantities.

Public scoping: A process whereby the public is given the opportunity to provide oral or written comments about the influence of a project on an individual, the community, and/or the environment.

Pulse: A group of whales; the term is applied to whales migrating across the Chukchi and Beaufort seas, when there are more individuals in each pod of whales and more pods than usual.

Pyrogenic: producing or produced by heat.

Q

R

Raptor: Bird of prey; includes eagles, hawks, falcons, and owls.

Recharge: Absorption and addition of water into the zone of saturation.

Record of Decision (ROD): A document separate from, but associated with, an Environmental Impact Statement, which states the decision, identifies alternatives (specifying which were environmentally preferable), and states whether all practicable means to avoid environmental harm from the alternative have been adopted, and, if not, why not (40 CFR § 1505.2).

Recoverable reserves: Oil and gas reserves that may be recoverable by the application of technology, but not necessarily commercially recoverable.

Reservoir (oil or gas): A subsurface body of rock having sufficient porosity and permeability to store and transmit fluids. Sedimentary rocks are the most common reservoir rocks because they have more porosity than most igneous and metamorphic rocks and form under temperature conditions at which hydrocarbons can be preserved. A reservoir is a critical component of a complete petroleum system.

Resident: A species that is found in a particular habitat for a particular time period (e.g., winter resident or summer resident) as opposed to a species found only when passing through during migration.

Resource Management Plan (RMP): Comprehensive land management planning document prepared by and for the Bureau of Land Management's administered properties under requirements of the Federal Land Policy and Management Act. Bureau of Land Management lands in Alaska were exempted from this requirement.

Rideup: A raised-relief ice formation that is formed when a moving ice sheet is forced up and over other structures such as land or ice.

Riffles: Stream segments where the water is relatively shallow, current velocity is relatively high, and sediments are coarse; riffles are located in between areas of deeper, slower water (pools).

Rift zone: Zone of faulting where rocks are pulled apart.

Riparian: Occurring adjacent to streams and rivers and directly influenced by water. A riparian community is characterized by certain types of vegetation, soils, hydrology, and fauna and requires free or unbound water or conditions more moist than that normally found in the area.

Risked mean: The arithmetic average of all possible resource outcomes weighted by their probabilities. Risked (unconditional) estimates of resources such as oil or natural gas consider the possibility that the area may be devoid of those resources. Statistically, the risked mean may be determined through multiplication of the mean of a conditional distribution by the related probability of occurrence.

Rolligon: A brand name or make of wheeled vehicle that exerts low pressure on the ground, and is designed to travel across sensitive areas such as tundra with minimal disturbance.

S

Satellite field: An oil reserve located near an existing oil development, allowing shared use of the infrastructure.

Scenic River: River designation, under the Federal Wild and Scenic Rivers Program, on the basis of undisturbed and scenic character. Scenic rivers are given special management criteria by federal agencies.

Scoping process: A part of the National Environmental Policy Act process; early and open activities used to determine the scope and significance of the issues, and the range of actions, alternatives, and impacts to be considered in an Environmental Impact Statement (40 CFR § 1501.7).

Sediments: Unweathered geologic materials generally laid down by or within waterbodies; the rocks, sand, mud, silt, and clay at the bottom and along the edge of lakes, streams, and oceans.

Sensitive species: Plant or animal species that are susceptible or vulnerable to activity impacts or habitat alterations. Species that have appeared in the Federal Register as proposed for classification or are under consideration for official listing as endangered or threatened species.

Short-term impacts: Impacts occurring during project construction and operation, and normally ceasing upon project closure and reclamation. For each resource the definition of short-term may vary.

Sidetrack well: A secondary well-bore drilled away from an original well-bore. A sidetracking operation may be done intentionally or may occur accidentally.

Significant: The description of an impact that exceeds a certain threshold level. Requires consideration of both context and intensity. The significance of an action must be analyzed in several contexts, such as society as a whole, and the affected region, interests, and locality. Intensity refers to the severity of impacts, which should weighted along with the likelihood of its occurrence.

SO_x: Sulfur oxides, including sulfur dioxide (SO_2). A product of vehicle tailpipe emissions.

Sociocultural: Of, relating to, or involving a combination of social and cultural factors.

Socioeconomic: Pertaining to, or signifying the combination or interaction of social and economic factors.

Soil horizon: A layer of soil material approximately parallel to the land surface that differs from adjacent genetically related layers in physical, chemical, and biological properties.

Solid waste: Garbage, refuse, and/or sludge produced during oil and gas exploration and development activities.

Spawning: Production, deposition, and fertilization of eggs by fish.

Special Use Permit: A permit issued under established laws and regulations to an individual, organization, or company for occupancy or use of federal or state lands for some special purpose.

Spill Prevention Control and Countermeasure Plan (SPCC): A plan that the Environmental Protection Agency requires to be on file within six months of project inception. It is a contingency plan for avoidance of, containment of, and response to spills or leaks of hazardous materials.

Spine road: The existing all-season gravel road connecting the oil and gas facilities at Kuparuk (Kuparuk Base Camp) with those at Prudhoe Bay (Prudhoe Bay Operations Center).

Standard: A model, example, or goal established by authority, custom, or general consent as a rule for the measurement of quantity, weight, extent, value, or quality.

Stipulation: A requirement or condition placed by the Bureau of Land Management on the leaseholder for operations the leaseholder might carry out within that lease. The Bureau of

Land Management develops standard stipulations that apply to all future leases within the Northeast National Petroleum Reserve – Alaska.

Stratigraphic trap: An oil or gas reservoir in which the hydrocarbons are trapped because of a lateral change in the physical characteristics of the reservoir or a change in the lateral continuity of the rocks.

Strike: The act of throwing a darting gun harpoon with a black powder or penthrite bomb into a whale. A strike may or may not result in a dead whale, which may or may not result in a landed whale. The International Whaling Commission considers and counts the number of strikes and landed whales in their quota allocation to the U.S. government (and hence to the Alaska Eskimos). Unused strikes can be transferred to other individuals or groups harvesting whales.

Subsistence: Harvesting of plants and wildlife for food, clothing, and shelter. The attainment of most of one's material needs (e.g., food and clothing materials) from wild animals and plants.

T

Talik: An unfrozen section of ground found above, below, or within a layer of discontinuous permafrost. These layers can also be found beneath water bodies in a layer of continuous permafrost.

Tectonic plate: A large, thin, relatively rigid plate that moves relative to other plates on the outer surface of the earth.

Terrestrial: Of or relating to the earth, soil, or land; inhabiting the earth or land.

Thermokarst: Land-surface configuration that results from the melting of ground ice in a region underlain by permafrost. In areas that have appreciable amounts of ice, small pits, valleys, and hummocks form when the ice melts and the ground settles unevenly.

Threatened species: A plant or animal species likely to become an endangered species throughout all or a significant portion of its range within the foreseeable future.

Total petroleum system: The combination of geologic components and processes necessary to generate and store hydrocarbons, including a mature source rock, migration pathway, reservoir rock, trap, and seal. Includes all the petroleum generated by related source rocks and resides in a volume of mappable rocks. Geologic processes act upon the petroleum system and control the generation, expulsion, migration, entrapment, and preservation of petroleum.

Traditional knowledge: An intimate understanding by indigenous peoples of their environment, which is grounded in a long-term relationship with the surrounding land, ocean, rivers, ice, and resources. This understanding includes knowledge of the anatomy, biology, and distribution of resources; animal behavior; seasons, weather, and climate; hydrology, sea ice, and currents; how ecosystems function; and the relationship between the environment and the local culture.

Transfer payment: Money given by the government to citizens, such as Social Security, welfare, and unemployment compensation.

Trophic system: The process and organisms that move food energy through the ecosystem, often termed a food chain.

Tundra: Level or undulating treeless plain characteristic of northern Arctic regions, consisting of black mucky soil with a permanently frozen subsoil and a dense growth of mosses, lichens, dwarf herbs, and shrubs.

Turbidity: A measure of the amount of suspended sediment in water.

U

V

W

Waterflooding: The injection of water into geological reservoirs to maintain or increase pressure in the reservoir and thereby assist in the extraction of oil.

Water quality: The interaction between various parameters that determines the usability or non-usability of water for on-site and downstream uses. Major parameters that affect water quality include: temperature, turbidity, suspended sediment, conductivity, dissolved oxygen, pH, specific ions, discharge, and fecal coliform.

Wetlands (biological wetlands): Those areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstance do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands include habitats such as swamps, marshes, and bogs (see jurisdictional wetlands).

Wildcat play: An unproven and prospective area of oil and gas potential that is outside of existing oil and gas producing areas or zones.

Wilderness: Land designated by Congress as a component of the National Wilderness Preservation System. For an area to be considered for Wilderness designation it must be roadless and possess the characteristics required by Section 2(c) of the Wilderness Act of 1964. These characteristics are: 1) naturalness - lands that are natural and primarily affected by the forces of nature; 2) roadless and having at least 5,000 acres of contiguous public lands; and 3) outstanding opportunities for solitude or a primitive and unconfined types of recreation. In addition, areas may contain “supplemental values,” consisting of ecological, geological or other features of scientific, educational, scenic or historical importance.

Acroynms

Acronyms, Abbreviations, and Symbols

AAAQS	Alaska Ambient Air Quality Standards
AAC	Alaska Administrative Code
AADT	Annual Average Daily Traffic (count)
ac	acre
ACI	Alaska Consultants, Inc.
ACIA	Arctic Climate Impact Assessment
ACMA	Alaska Coastal Management Act
ACMP	Alaska Coastal Management Program
ACP	Arctic Coastal Plain
AC&W	Aircraft Control and Warning
ADCED	Alaska Department of Community and Economic Development
ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish and Game
ADGC	Alaska Division of Governmental Coordination
ADNR	Alaska Department of Natural Resources
ADOL	Alaska Department of Labor
ADOLWD	Alaska Department of Labor and Workforce Development
ADOTPF	Alaska Department of Transportation and Public Facilities
ADR	Alaska Department of Revenue
AGL	Above Ground Level
AHRS	Alaska Heritage Resources Survey
ANCSA	Alaska Native Claims Settlement Act
ANGTS	Alaska Natural Gas Transportation System
ANILCA	Alaska National Interest Lands Conservation Act
ANS	Alaska North Slope; Arctic North Slope
ANWR	Arctic National Wildlife Refuge
AO	Authorized Officer
AOGCC	Alaska Oil and Gas Conservation Commission
AQRV	Air Quality Related Values
ARCO	Atlantic Richfield Company
ARL	Arctic Research Laboratory
AS	Alaska Statutes
ASDP	Alpine Satellite Development Project
ASRC	Arctic Slope Regional Corporation
ASTt	Arctic Small Tool tradition
BA	Biological Assessment
bbl	barrel
Bbbl	Billion barrels

BCBS	Bering-Chukchi-Beaufort Seas
BD/DR	Building Demolition and Debris Removal
BEA	Bureau of Economic Analysis
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BP	British Petroleum
BPXA	British Petroleum Exploration – Alaska
CAA	Clean Air Act
CAFF	Conservation of Arctic Flora and Fauna
CAH	Central Arctic Herd (of caribou)
CCP	Central Compressor Plant
CD	Colville Delta
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CIAP	Coastal Impact Assistance Program
CIP	Capital Improvement Project
CIRI	Cook Inlet Region Incorporated
cm	centimeter
CM	Cost of Mitigation
CMP	Coastal Management Program
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CPF	Central Production Facility
CRA	Circumpolar Research Associates
CRSA	Colville River Special Area
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DDT	Dicholorodiphenyltrichloroethane
DEW-Line	Distant Early Warning Line (System)
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EO	Executive Order
EPCA	Energy Policy and Conservation Act
ESA	Endangered Species Act
FEP	Full Economic Potential
FFD	Full Field Development
FLIR	Forward Looking Infrared Radar
FR	Federal Register
FLPMA	Federal Land Policy and Management Act
ft	foot/feet
FY	Fiscal Year

gal	gallon(s)
gal/day	gallons per day
GAO	U.S. General Accounting Office
GMU	Game Management Unit
GOR	Gas-to-Oil Ratio
GTL	Gas-to-Liquid Ratio
HRAF	Human Relations Area Files, Inc.
H_2S	Hydrogen Sulfide
IAI	Impact Assessment, Inc.
IAP	Integrated Activity Plan
ICAS	Iñupiat Community of the Arctic Slope
in	inch
IPCC	Intergovernmental Panel on Climate Change
IRA	Indian Reorganization Act
IRP	Industrial Roads Program
ISER	Institute of Social and Economic Research
km	kilometer(s)
km^2	square kilometer(s)
KOP	Key Observation Point
KRU	Kuparuk River Unit
LADS	Light Automated Drilling System
lb	pound(s)
LC_{50}	lethal dose at which half of the organisms die
LMR	Land Management Regulation
LNG	Liquid Natural Gas
LPG	Liquefied Petroleum Gas
LRR	Long Range Radar
LRRS	Long Range Radar Site
LUEA	Land Use Emphasis Area
m	meter(s)
m^2	square meter(s)
m^3	cubic meter(s)
Mcf	Thousand cubic feet (of gas)
Meq/l	Milliequivalents per liter
mg	milligram(s)
mg/l	milligrams per liter
mi	mile(s)
mi^2	square mile(s)
MMbbl	Million barrels (of oil)
MMbpd	Million barrels per day (of oil)
MMcfd	Million cubic feet per day (of gas)
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
Mpa	megapaseals

M-SFMCA	Magnuson-Stevens Fishery Management and Conservation Act
MOU	Memorandum of Understanding
MWD	Measurement while Drilling
NA	Not Applicable
NAAQS	National Ambient Air Quality Standard
NARL	Naval Arctic Research Laboratory
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NO	Nitric Oxide
NO_x	Nitrogen Oxides
NO_2	Nitrogen Dioxide
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NPR-A	National Petroleum Reserve-Alaska
NPRPA	Naval Petroleum Reserves Production Act
NRC	National Research Council
NRHP	National Register of Historic Places
NSB	North Slope Borough
NSBMC	North Slope Borough Municipal Code
NSMOG	North Slope Management Oversight Group
NSO	No Surface Occupancy
NSSI	North Slope Initiative
NWI	National Wetlands Inventory
NWS	Northern Warning System
O_3	Ozone
OCS	Outer Continental Shelf
OCSEAP	Outer Continental Shelf Environmental Assessment Program
OCSLA	Outer Continental Shelf Lands Act
OHA	Office of History and Archaeology
OHV	Off-highway Vehicle
ONR	Office of Naval Research
OPEC	Organization of the Petroleum Exporting Countries
ORV	Off-road Vehicle
OSC	On-scene Coordinator
OWM	Oil-weathering Model
PAH	Polycyclic Aromatic Hydrocarbons
PAI	Phillips Alaska, Inc.
PET-4	Naval Petroleum Reserve Number 4
pH	Measure of hydrogen ion concentration in the water
PL	Public Law
PM	Particulate Matter
$PM_{2.5}$	Particulate matter > 2.5 microns in diameter

PM_{10}	particulate matter > 10 micron in diameter
POL	Petroleum, Oil, and Lubricants
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
PSD	Prevention of Significant Deterioration
RCRA	Resource Conservation and Recovery Act of 1976
RFSUNY	Research Foundation of the State University of New York
RI/FS	Remedial Investigation and Feasibility Study
RMP	Resource Management Plan
RMT	Research and Monitoring Team
RN	Roaded Natural
ROD	Record of Decision
ROP	Required Operating Procedure
ROS	Recreation Opportunity Spectrum
ROW	Right-of-Way
SAP	Subsistence Advisory Panel
SHPO	State Historic Preservation Officer
SO_x	Sulfur Oxides
SO_2	Sulfur Dioxide
SQRU	Scenic Quality Rating Unit
SPM	Semi Primitive Motorized
SRBA	Stephen R. Braund and Associates
SRP	Special Recreation Permit
SRR	Short Range Radar
SRRS	Short Range Radar Site
TAGS	Trans Alaska Gas System
TAPS	Trans-Alaska Pipeline System
TAPSO	Trans-Alaska Pipeline System Owners
Tcf	Trillion cubic feet (of gas)
TEA	Transportation Enhancement Act
TERA	Troy Ecological Research Associates
TLCH	Teshekpuk Lake Caribou Herd Area
TLH	Teshekpuk Lake Herd (of caribou)
TLUI	Traditional Land Use Inventory
TVD	True Vertical Depth
UAA	University of Alaska, Anchorage
UIC	Ukpeagvik Innpiat Corporation
UL	Unavailable for Leasing
USC	United States Code
USACE	U.S. Army Corps of Engineers
USDOC	U.S. Department of Commerce
USDOD	U.S. Department of Defense
USDOE	U.S. Department of Energy

USDOI	U.S. Department of Interior
USDOL	U.S. Department of Labor
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGCRP	U.S. Global Change Research Program
USGS	U.S. Geological Survey
VOC	Volatile Organic Compounds
VRM	Visual Resource Management
VSM	Vertical Support Member
WAC	White Alice Communications
WACS	White Alice Communication System
WAH	Western Arctic Herd (of caribou)
WSR	Wild and Scenic Rivers
WSRA	Wild and Scenic Rivers Act
yd	yard(s)
yd^3	cubic yard(s)
Y-K Delta	Yukon-Kuskokwim Delta
≥	greater than or equal to
≤	less than or equal to
>	greater than/more than
<	less than
$\mu g/m^3$	micrograms per cubic meter
°F	degrees Fahrenheit